MAY 31 – JUNE 4 / 31 MAI – 4 JUIN

2010

CROWNE PLAZA
101 RUE LYON STREET

CMOS
SCMO

OTTAWA CANADA

44th Annual CMOS Congress / 36th Annual Scientific Meeting of CGU / 3rd Joint CMOS-CGU Congress
44e Congrès annuel de la SCMO / 36e Rencontre scientifique annuelle de l'UGC / 3e Congrès organisé conjointement par la SCMO et l'UGC

Canadian Meteorological and Oceanographic Society / La Société canadienne de météorologie et d'océanographie
Canadian Geophysical Union / Union géophysique canadienne

www.cmos.ca/congress2010

Sponsors

On behalf of all the delegates the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union wish to acknowledge and thank the major supporters of our 3rd Joint CMOS-CGU Congress 2010 (44th Annual CMOS Congress and the 36th Annual Scientific Meeting of CGU).

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	Natural Resources Canada	www.nrcan-rncan.gc.ca

Canadian Meteorological and Oceanographic Society (CMOS)
Canadian Geophysical Union (CGU)

44th CMOS Congress
36th CGU Annual Meeting
Ottawa 2010

31 May - 4 June 2010

Our Earth

Our Air

Our Water

Our Future

Editor : Mario Ouellet

PROGRAM

http://www.cmos.ca/congress2010/

Abstracts available online at
https://www1.cmos.ca/abstracts/abstracts115/congress_schedule.asp

ISBN 978-0-9732812-8-6

NOTES

Internet access: Wireless access to the Internet will be available during the Congress. The password is CMOSCGU (all capitals). No username is required.

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Welcome from the Minister of the Environment Jim Prentice

I am pleased to welcome all delegates to the Canadian Meteorological and Oceanographic Society's 44th Annual Congress being held this year in Ottawa.

This year's theme "Our Earth, Our Air, Our Water and Our Future" is very relevant to the current priorities of both Environment Canada and the country as a whole. I like this theme because its message is simple – if we dedicate our time and energy toward the betterment and preservation of our earth, air and water, Canada's future will strongly benefit.

This is also why I take a great deal of pride in the efforts of the hundreds of Canadian meteorologists, engineers, climatologists, technicians, scientists and researchers in meteorology and oceanography. Your efforts, along with those of our private sector partners, positively impact us all each and every day.

At Environment Canada, we are dedicated to providing all Canadians with dependable and accurate weather predictions. These predictions and warnings help our citizens to better plan their lives, and allow them to protect themselves, their families and their property from the effects of severe weather.

The department is also home to some of the world's best weather forecasting experts, combined with state-of-the-art forecasting equipment. The commitment and service these experts provide to Canadians is incredibly important, not only to our safety and security, but to the environmental and economic well-being of this country.

From coast to coast to coast, Canadians benefit from Canada's world-renowned expertise in environmental prediction and the dedication of the meteorologists and oceanographers who have assembled at this Congress.

May your deliberations stimulate debate and strengthen links that will further Canada's commitment to offer all Canadians with the environmental prediction measures that not only meet, but exceed our standard of excellence.

Jim Prentice
Minister of the Environment

Welcome from the Minister of Natural Resources Christian Paradis

I want to extend my warmest greetings to the organizing committee and all of you attending the third joint congress between the Canadian Meteorological and Oceanographic Society and the Canadian Geographic Union.

Like your two important national organizations, the government of Canada has long been an active contributor in the areas represented at the CMOS/CGU Congress. We share your close connection to the theme of this five-day conference in Ottawa: Our Earth, Our Air, Our Water: Our Future.

A large part of Natural Resources Canada's work deals with the most dynamic aspects of the Earth's changing nature. As part of NEPTUNE and VENUS projects, two of the world's most advanced undersea cabled network observatories, scientists at the department's Geological Survey of Canada (GSC) are helping project partners to monitor earthquakes and study slope stability in offshore British Columbia. In Haiti, the GSC recently installed the country's first seismic monitoring network.

Geosciences help define Canada, its physical features and endowment of oil, gas and mineral resources. The Government of Canada recently renewed NRCan's Targeted Geoscience Initiative, which, along with the Geo-mapping for Energy and Minerals program, provides industry, government and Canadians with valuable geoscientific information to improve their exploration effectiveness.

Our expertise is at work in the collection and interpretation of scientific data to support Canada's submission to the United Nations Commission on the Limits of the Continental Shelf. On land, the department's Groundwater Geoscience program is accelerating mapping of key regional aquifers for completion by 2025.

These and many other activities demonstrate how knowledge of the Canadian landmass, and processes that affect it, can be harnessed to improve our lives.

Let me assure you that our government is well aware of the scientific contributions of your membership to our nation. On behalf of Government of Canada, I wish you a successful conference.

The Honourable Christian Paradis, P.C., M.P.
Minister of Natural Resources

Welcome from the Minister of Fisheries and Oceans
Gail Shea

It is my pleasure to welcome you to the nation's capital for your third annual joint Congress.

At Fisheries and Oceans Canada, we share your commitment to conserving, protecting and developing the oceans in a sustainable manner. In keeping with the theme of this year's conference, we view as fundamental the interconnectivity between earth, air, water, and our future.

Canada's oceans are an integral part of our identity as a nation. They form the heart of our way of life in many communities, and are valued as an essential resource by all Canadians.

Covering 71 percent of the earth's surface, oceans are also important to life on our planet. They help provide the food we eat and purify the water we drink. They generate much of the oxygen we breathe and help regulate our climate by capturing, storing and distributing heat. Oceans also spur the global economy, creating jobs and sustaining communities.

Protecting Canada's oceans and understanding our climate requires an integrated management approach across various disciplines and levels of government. CMOS-CGU Congress 2010 is an excellent opportunity to share knowledge across disciplines and amongst government leaders.

Our Government is working with all of its partners to ensure that future generations of Canadians will inherit healthy oceans and ocean resources, and that our collective use of these resources is sustainable.

I wish you a very productive conference and hope you take some time to enjoy the National Capital Region.

The Honourable Gail Shea, P.C., MP
Minister of Fisheries and Oceans

Welcome from the Premier of Ontario

Ontario

Premier of Ontario - Premier ministre de l'Ontario

May 31 – June 4, 2010

A PERSONAL MESSAGE FROM THE PREMIER

On behalf of the Government of Ontario, I am delighted to extend warm greetings to everyone attending the Third Joint Congress of the Canadian Meteorological and Oceanographic Society (CMOS) and the Canadian Geophysical Union (CGU).

Ontarians — and all Canadians — are proud of the knowledge and expertise embodied in organizations such as CMOS and the CGU. It is in building our scientific prowess that we not only remain competitive as a nation, but also further our understanding of the processes that shape our entire world. I commend the members of CMOS for their continued hard work in advancing meteorology and oceanography in Canada and of the CGU for their steadfast dedication to deepening our understanding of the geophysical sciences.

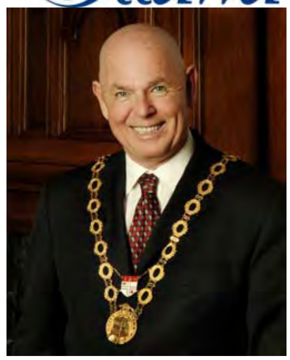
This year's joint congress, guided by the theme *Our Earth, Our Air, Our Water — Our Future*, offers participants the chance to enjoy informative speakers and presentations, take part in science sessions addressing issues ranging from climate change to the Arctic environment, and network with colleagues.

Organizing a joint event of this scope and calibre is a major undertaking. That is why I would like to thank all those who have devoted time and effort to making this congress possible.

Please accept my best wishes for a rewarding and successful congress.

Dalton McGuinty
Premier

Welcome from the Mayor of Ottawa



Larry O'Brien
Mayor / Maire

On behalf of Members of Ottawa City Council, representing 900,000 residents, it is my distinct pleasure to extend a very warm welcome to the delegates participating in the *3rd Joint Congress of the Canadian Meteorological and Oceanographic Society (CMOS)* and the *Canadian Geophysical Union (CGU),* as well as the *44th Congress of the CMOS* and the *36th Annual Scientific Meeting of the CGU,* all taking place in the heart of our nation's capital from May 31st to June 4th 2010.

As Head of Council, I want to lend my unequivocal support to the *CMOS* and the *CGU* for their collaborative efforts to provide forums for scientists, researchers and experts representing the fields oceanography, meteorology and geophysics to network, share ideas, partake in scientific sessions, as well as attend plenary presentations, workshops and lectures.

In addition, I want to congratulate the meetings' hosts, the keynote speakers, facilitators, contributors, sponsors and volunteers for their dedication of time, energy, expertise and resources to the successful organization of these major scientific assemblies of national and international scope.

The Congress theme *Our Earth, Our Air, Our Water: Our Future,* will allow some 1,000 delegates to explore important environmental topics including ocean climate change, health issues of weather and climate, air quality and wind energy.

As Mayor of the host city, I invite visitors to discover the numerous civic landmarks of historical significance as well as the abundance of national treasures and heritage sites housed in Canada's capital.

Allow me to convey my best wishes to all the delegates for very productive and most rewarding assemblies.

Sincerely,

Larry O'Brien
Mayor

110 Laurier Avenue West, Ottawa, ON K1P 1J1/110, avenue Laurier Ouest, Ottawa ON K1P 1J1
Tel/tél. : 613-580-2496 Fax/téléc. : 613-580-2509
e-mail/courriel : Larry.OBrien@ottawa.ca
Web : ottawa.ca

A Word of Welcome from the Societies and the Committees

Welcome from the President of the CMOS

On behalf of CMOS, I welcome you to the 2010 Congress "Our Earth, Our Air, Our Water, OUR FUTURE". The Congress provides us with an opportunity to broadcast our scientific advances, learn of new scientific insight, recognize outstanding colleagues, make new friendships and renew old ones. This year CMOS will host the Congress jointly with the Canadian Geophysical Union, a partnership that worked so well in St. John's in 2007 that our two societies chose to renew it in Ottawa in 2010. A special thanks to John Falkingham, chair of the Local Arrangements Committee, as well as to Dick Stoddart and Rod Blais, co-chairs of the Scientific Program Committee. They lead more than 30 volunteer members of their committees, with many more assisting during the week of Congress. Work began even before last year's Congress and many volunteers will continue after this summer.

Our organizers rely on the number of abstracts to foretell attendance; this year the numbers predict a high registration and allow us to devote more funds to support student travel to the Congress.

In addition to presenting and listening to science papers and plenary speakers, I encourage all to visit the exhibitors and participate in the CMOS annual general meeting. Other events are the awards dinners and special luncheons and the public lecture.

Best wishes to all for an exciting and productive Congress in Ottawa.

Bill Crawford,
CMOS President

Welcome from the President of the CGU

Welcome to the 3rd CMOS-CGU Joint Congress 2010 “Our Earth, Our Air, Our Water, Our Future ”.

This Joint Congress is expected to be highly successful surpassing all expectations! With nearly 800 abstracts and over 100 technical sessions, the Local Arrangements Committee (LAC) and the Scientific Program Committee (SPC) have a very challenging, yet pleasant task, to accommodate everyone in the four-day technical program. We will hear the most recent scientific advances in all fields of geophysical sciences, including several multidisciplinary research topics and initiatives. The plenary and technical sessions will be complemented with various workshops in which progress in collaborative projects and new initiatives will be discussed and planned. Make sure that you don’t miss them!

The 2010 CMOS-CGU Joint Congress is within the scope and objectives of the Canadian Societies for the Geophysical Sciences (CSGS), and paves the way for the promotion and strengthening of its vision and mission. The Canadian Geophysical Union is very pleased to be a part of, contribute to, and have a strong presence in this Congress.

Both, CMOS and CGU strongly encourage and promote the active participation of students in all of their annual congresses and meetings, and this Joint Congress is no exception. Many student paper awards and travel grants are in place to support and sponsor our young scientists and researchers who will be the heart and soul of our societies in the not too distant future. For this purpose, the LAC, in response to the overwhelming student participation, recently proposed to increase the travel grant budget to $20,000, which was happily endorsed by the presidents of both societies.

In addition to the technical sessions and workshops, we have been organizing our Icebreaker, a public lecture, our annual general meetings, luncheons, and award dinners. These are essential activities that tie into the technical program, acknowledge the contributions and achievements of our colleagues and friends, and create a conductive social atmosphere. In particular, I encourage all CGU members to embrace and support our four Sections, namely Hydrology, Geodesy, Solid Earth and Biogeosciences, and show initiative and active participation.

Looking forward to seeing you in Ottawa for a stimulating, dynamic, and productive Joint Congress!

Spiros Pagiatakis
CGU President

Welcome from the Science Program Committee

On behalf of the Scientific Program Committee (SPC) we are pleased to welcome you to the joint 2010 CMOS/CGU Congress. The theme of the Congress "Our Earth, Our Air, Our Water: Our Future", and the resulting 800 oral and poster presentations, truly reflect the breadth, diversity and the increasingly interdisciplinary nature of the research communities of the two Societies, including meteorologists, oceanographers, climatologists, geodesists, hydrologists, limnologists, biogeoscientists, earth and cryosphere scientists and other environmentalists.

The broad scientific scope of this Congress is also demonstrated in the plenary presentations from both Canadian and international experts. The scientific program is organized into 10 over-arching theme categories, 65 dedicated sessions, many of which were multi-part, resulting in 119 sessions for 650 oral presentations and 150 poster presentations. With fourteen sessions running in parallel throughout the duration of Congress, the SPC and session conveners were space and time challenged to accommodate all requests. The SPC believes that the poster sessions are an integral part of the Congress and encourages you to attend the sessions on Tuesday and Thursday afternoons.

Dick Stoddart

If students are the future of both Societies, we are in good hands. Student travel bursary applications doubled in numbers from last year. The SPC was pleased to respond by doubling the overall dollar amount available for the some 82 successful applicants. Of the abstracts submitted, 240 were from students representing 30% of the program.

Rod Blais

We would like to give special thanks to all the volunteers who made this Congress possible, particularly the members of the Scientific Committee, the Local arrangements Committee and the CMOS head office staff for their time and expert advice.

We hope you will enjoy this excellent opportunity for interactions and exchanges with experts from home and around the world. Welcome to Ottawa!

Dick Stoddart and Rod Blais
Co-Chairs, Scientific Program Committee

Welcome from the Local Arrangements Committee

On behalf of the Local Arrangements Committee, it is my pleasure to welcome you to the 3rd Joint CMOS-CGU Congress - the 44th Congress of the Canadian Meteorological and Oceanographic Society and the 36th Annual Scientific Meeting of the Canadian Geophysical Union. The theme - "Our Earth, Our Air, Our Water: Our Future" – underlines the interconnections in our environment and the responsibility we share to understand it for our future prosperity.

After a full day of CMOS and CGU committee meetings and workshops, the Congress will get officially started with an Icebreaker Reception on Monday evening in the penthouse of the Crowne Plaza. The splendid 360º view of Ottawa, Gatineau, the rivers and the hills beyond will provide the backdrop for an evening of libation, light jazz and friendly conversation as old friendships are renewed and new ones made.

The main business of the Congress begins on Tuesday and, as you can see from the agenda and their own welcome message, the Scientific Program Committee has prepared a remarkable program.

John Falkingham

Social activities will continue on Wednesday with the Patterson-Parsons Luncheon for CMOS members and an informal barbecue for CGU members. Wednesday evening will bring an opportunity for CMOS and CGU members to mingle at a combined reception and the evening will continue with the Public Lecture by Dr. Warwick Vincent. This lecture, open and free to the general public, continues the tradition of science education. I encourage all Congress delegates to join with the public for a stimulating and engaging presentation.

On Thursday evening, CMOS and CGU will hold separate, but simultaneous, Awards Banquets. The size of the combined societies makes it impossible to hold a joint banquet in the space available to us this year. Nevertheless, I sincerely hope that members of CMOS and CGU will take every opportunity to interact with one another.

The Crowne Plaza is conveniently located in downtown Ottawa close to a multitude of cultural and historic attractions. Take a trolley bus around town or a boat trip down the Rideau Canal; visit Parliament Hill, the Supreme Court, the National Art Gallery or any of the several museums on either side of the Ottawa River. You will find dozens of restaurants, cafés and pubs around the hotel. Stroll down the Sparks Street Mall with its shops and boutiques or venture into the Byward Market to sample the nightlife.

It has taken the dedicated work of a large number of volunteers over the past two years to prepare for this Congress - the largest that CMOS and the CGU has ever organized. I wish to thank all of the members of the LAC together with their sub-committees for their tireless dedication. Similarly, to the student volunteers and the local CMOS and CGU members who are donating their time to keep things running smoothly this week – a huge thank-you.

The Local Arrangements Committee and our volunteers are at your disposal during the week if you have any questions. Just look for our red vests. The management and staff of the Crowne Plaza will be equally eager to assist. We all hope that you will enjoy not only the Congress but can also take in the sights and sounds of Canada's capital city.

John Falkingham
Chair
Local Arrangements Committee
CMOS-CGU Congress 2010

A Word About the Societies

CMOS

The Canadian Meteorological and Oceanographic Society (CMOS) is the national society of individuals and organizations dedicated to advancing atmospheric and oceanic sciences and related environmental disciplines in Canada. The Society's aim is to promote meteorology and oceanography in Canada. It is a non-governmental organization serving the interests of meteorologists, climatologists, oceanographers, limnologists, hydrologists and cryospheric scientists across Canada and internationally. CMOS has a rich history dating back to 1939 when it was known as the Canadian Branch of the Royal Meteorological Society. CMOS was officially created in 1967 as the Canadian Meteorological Society and adopted its present name in 1977, following an invitation by the Canadian Meteorological Society to the oceanographic community in Canada to join the Society.

CGU

On October 24, 1945, the National Research Council (NRC) of Canada convened the first meeting of an Associate Committee to advise it on the needs of geophysics, with J. T. Wilson as the Chairman of the committee. In 1946, this committee was amalgamated with the Canadian committee for the International Union of Geodesy and Geophysics (IUGG) to form the Associate Committee of Geodesy and Geophysics (ACGG) of the NRC. Activities of geophysicists in Canada were coordinated by ACGG by forming a number of subcommittees.

In 1974, the ACGG was replaced by a professional society called "The Canadian Geophysical Union, a joined Division of the Geological Association of Canada (GAC) and of the Canadian Association of Physicists (CAP)", and with J. T. Wilson as its first president. The Canadian Geophysical Union became an independent organization in 1988, but today geophysicists still can join CGU by joining CAP or the Geophysics Division of GAC. CGU comprises four scientific sections: Hydrology (since 1993), Geodesy (since 2002), Solid Earth (since 2009) and Biogeosciences (since 2009). Now with about 500 members, CGU serves as the national focus for geophysical sciences and carries on the traditional responsibility of representing Canada in the IUGG through a Canadian National Committee (CNC/IUGG).

Student Travel Bursary Recipients

Student	University
Alipour, Samira	University of Western Ontario
Assini, Jane	York University
Baglaenko, Anton	University of Waterloo
Bedard, Joel	École de technologie supérieure
Beedle, Matt	University of Northern British Columbia
Bhattacharya, Pathikrit	University of Western Ontario
Blanchette, Jean-Philippe	L'Université du Québec à Montréal (UQAM)
Brazzard, Andrea	McMaster University
Brunet, Nathalie	University of Saskatchewan
Bunn, Melissa	University of Waterloo
Burles, Katie	University of Lethbridge
Casson, Nora	Trent University
Chen, Bin	McMaster University
Cho, Nelson	University of Western Ontario
Christensen, Brendan	University of Calgary
Corkum, Mathew	York University
Croft, Alison	York University
Di Luca, Alejandro	L'Université du Québec à Montréal (UQAM)
Duval, Tim	McMaster University
Elghazouly, Ahmed	University of Calgary
Fargey, Shannon	University of Manitoba
Fereydouni, Azadeh	University of Western Ontario
Gaitan, Carlos	University of British Columbia
Ghofrani, Hadi	University of Western Ontario
Giroux, Kayla	Wilfrid Laurier University
Halla, Jamie	York University
Harder, Silvie	University of Victoria
Higginson, Simon	Dalhousie University

Student	University
Hodal, Michal	University of British Columbia
Huang, Suo	McMaster University
Ince, Elmas	University of Calgary
Katavouta, Anna	University of Alberta
Kenward, Andrea	Wilfrid Laurier University
Khajehnouri, Yasaman	École Polytechnique de Montréal
Kiarasi, Souhyant	University of Western Ontario
Koumoulas, Panagiotis	York University
Lago, Veronique	University of Alberta
Lau, Justin	University of British Columbia
Leduc, Martin	L'Université du Québec à Montréal (UQAM)
Lefort, Stelly	McGill University
Lu, Zhaoshi	Memorial University
Ma, Zhimin	Memorial University
Mahmood, Sharif	University of Calgary
Malik, Khalid	York University
Markovic, Marko	L'Université du Québec à Montréal (UQAM)
Marsh, Chris	University of Saskatchewan
Mashayek, Ali	University of Toronto
Matveev, Alex	L'Université du Québec à Montréal (UQAM)
McLarty, Jennifer	York University
Mladjic, Bratislav	L'Université du Québec à Montréal (UQAM)
Mosquera, John	University of Waterloo
Nagare, Ranjeet	University of Western Ontario
O'Leary, Sheilagh	Memorial University
PaiMazumr, Debasish	L'Université du Québec à Montréal (UQAM)
Pal, Jalpa	University of Western Ontario
Paque, Gwenaelle	L'Université du Québec à Montréal (UQAM)
Paquin, Jean-Philippe	L'Université du Québec à Montréal (UQAM)

Student	University
Paquin-Ricard, Danahé	L'Université du Québec à Montréal (UQAM)
Payeur-Poirier, Jean-Lionel	Université Laval
Perro, Chris	Dalhousie University
Pryse-Phillips, Amy	Memorial University
Ross, Andrew	Concordia University
Sanchez, Laura	University of Western Ontario
Sato, Mei	University of Victoria
Sawyer, Ryan	University of Western Ontario
Seagram, Annie	University of British Columbia
Seitz, Nicole	University of Saskatchewan
Shan, Shiliang	Dalhousie University
Smith, Karen	University of Toronto
Soontiens, Nancy	University of Waterloo
Steelman, Colby	University of Waterloo
Steinmoeller, Derek	University of Waterloo
Thompson, Dan	McMaster University
van der Laan, Michael	University of British Columbia
Vanos, Jenni	University of Guelph
von de Wall, Simon Julius	University of Victoria
Wagner, Michael	University of Alberta
Yadghar, Amir	Concordia University
Yan, Xiaoqin	University of Northern British Columbia
Yang, Dejian	University of Northern British Columbia
Zhang, Ying	Memorial University
Zhou, Yang	Dalhousie University

Local Arrangements Committee

John Falkingham	Chair
Wayne Richardson	Treasurer
Sean Carey	Secretary
Isabel Ruddick	Registration
Erica Wilson / Bruce Ramsay	Facilities
Wayne Lumsden / Brian Beamish	IT / AV
Paul Pestieau	Communications
Mario Ouellet	Program Book
Bob Jones	Webmaster
Anne O'Toole	Sponsors / Exhibits
Oscar Koren / Terry Fanning	Exhibits
Sheila Bourque / Emily Bourque	Teachers' day
Elaine Moores	Volunteer Coordinator
Spiros Pagiatakis / Kathy Young	CGU Representatives
Ian Rutherford	CMOS Executive Director
Denis Bourque	CMOS Ottawa Centre Chair
Matthew Ladd	At large

Scientific Program Committee

Dick Stoddart / Rod Blais - Co-Chairs	John Stone - EC/MSC (retired)
Altaf Arain - McMaster University	Leah Braithwaite - EC/Can Ice Service
Doug Whelpdale - EC/MSC (retired)	Peter Taylor - York University
Gail Atkinson - University of Western Ontario	Sam Butler - University of Saskatchewan
Howard Freeland - DFO/IOS	Sean Carey - Carleton University
Ian Rutherford - CMOS	Spiros Pagiatakis - York University
Joe Henton - NRCan	Tim Aston - CFCAS

Volunteers

John Anderson	Panagiotis Koumoulas
Martha Anderson	Harry Lamb
Matt Arkett	Andy (Yuehua) Lin
Richard Asselin	Ann McMillan
Jane Assini	Ilona Monahan
Ryan Ballingall	Colleen Mortimer
Paul Beckwith	Lidia Nikitina
Wendy Benjamin	Lynn Pogson
Yvon Bernier	Sierra Pope
Jorge Urrego Blanco	Jana Ramsay
Mike Brady	Louise Reid
Dawn Conway	John Reid
Allison Croft	Amanda Reinwald
Kelly Crowe	Shiliang Shan
Lesley Elliott	Jennifer Smith
Cheryl Falkingham	Margaret-Anne Stroh
Irenka Farmilo	Marty Taillefer
Norah Foy	Colleen Turnbull
Dave Henderson	Anne-Marie Valton
John Hollins	Wesley Van Wychen
Dave Huddlestone	Adrienne White
Sergio Ieropoli	Katherine Wilson
Richard Jones	Amir Yadghar
Peter Kimbell	

Information

Guidelines for Oral Presentations

Please ensure the electronic file name of your presentation includes the session number, paper number and presenter name. We will have volunteers in the lecture theatres at least 30 minutes before the start of the sessions to assist with uploading of presentations. Your presentation must be brought to your session room at least 15 minutes prior to the start of your session. The Congress computers run Microsoft Windows XP Pro with the following software: Microsoft Office 2007 Professional / PowerPoint, Adobe Acrobat Reader, Quicktime Player and Windows Media Player. Please bring your presentations on one of the following media: USB hard drive, USB flash drive, CD or DVD. Presenters will be able to edit their presentations on site using a laptop that has a USB port. Note that if video clips are used in the presentation they must be downloaded into the same directory as the main PowerPoint presentation. Presentations created on a Macintosh and converted to run on a PC should be tested on a PC before arriving at the meeting. In cases where the presentation conversion is not possible, we will attempt to accommodate connecting a Macintosh computer directly to the LCD projector. Any links should be checked at the meeting to ensure that they remain functional. Please note that there is no internet connection on the presentation computers. There will be a computer and projector in the Speakers Preparation room where speakers can test drive their presentations.

Guidelines for Poster Presentations

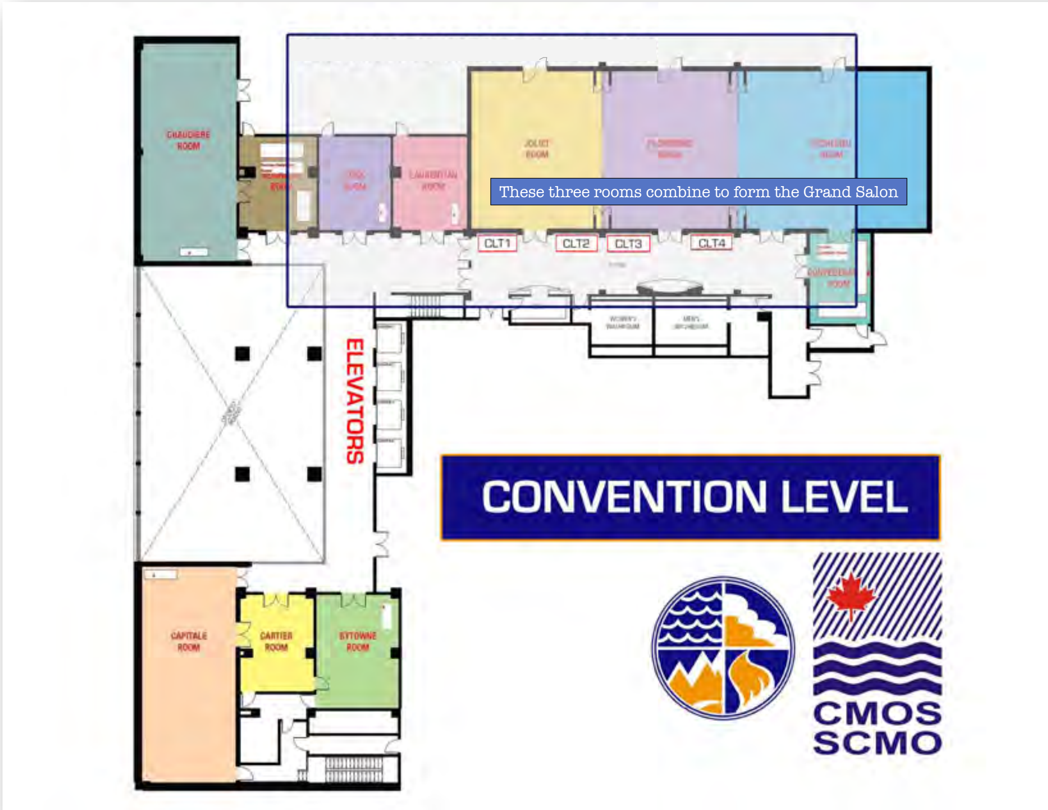
The Science Posters for the Congress will be located on the Terrace of the Crowne Plaza Hotel. Each poster is allocated a space of 4 ft (1.2 m) by 4 ft (1.2 m). The poster boards can accept both Velcro and pins (a supply of both will be available). Posters can be mounted any time after 15:30 on Monday for the Tuesday presentations and any time after 15:30 on Wednesday for the Thursday presentations. Presenters will be required to be by their posters to discuss their work during the assigned poster session. Posters are to be removed by the end of the morning refreshment break on the day after their presentation.

Session Chairs' Guidelines

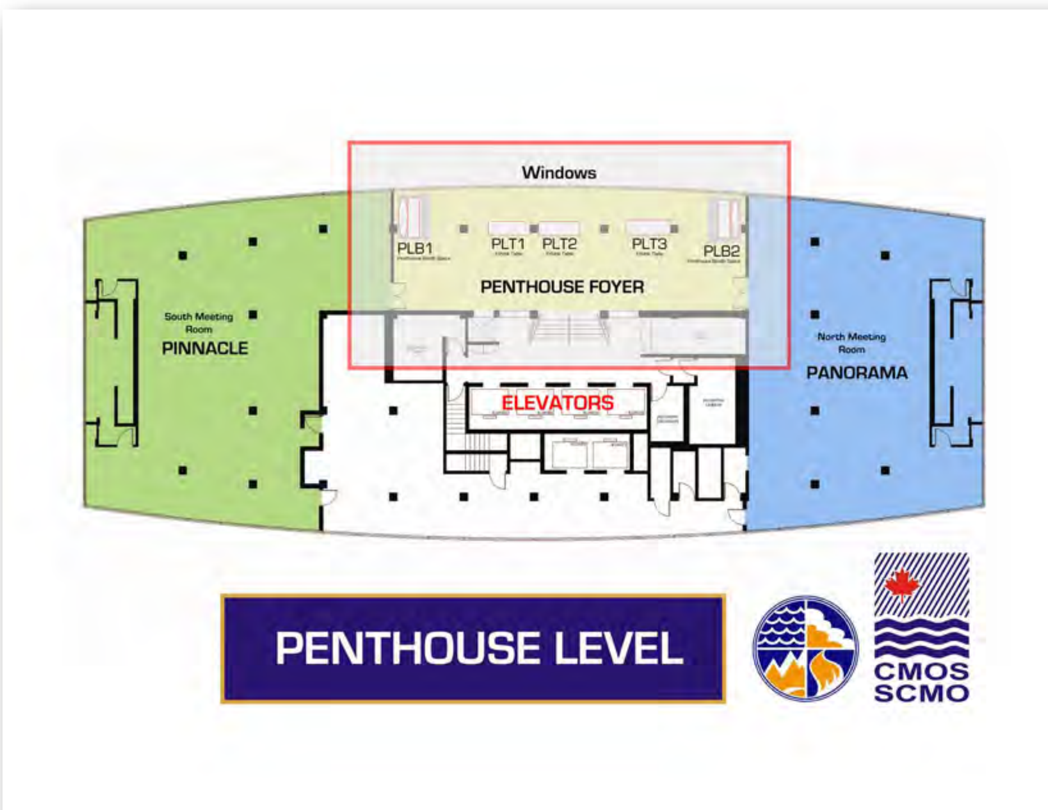
One assistant will be present in each session room. The assistant will be available to help with any A/V or computer technical problem. Each computer will be equipped with the following software: Microsoft Office 2007 Professional / PowerPoint, Adobe Acrobat Reader, Quicktime Player and Windows Media Player. Before the session starts, the chairperson should touch base with the assistant, check if all talks are loaded in the computer and if all speakers are in the session room. Before the start of the session, the chairperson should verify that the person to speak is listed in the program as the presenter, or one of the authors, or otherwise is sufficiently acquainted with the work in order to answer questions. The chairperson is responsible for opening and closing the session on time. The time allocated for a presentation includes the time for questions and discussions as well as the change over. In consideration of many parallel sessions, the time schedule of the session should be strictly kept. A timer will be available in each session room. Should an unforeseen gap in the schedule appear, it should be filled with a standby paper, an extended question period on previous talks or a short description of the poster sessions associated with the session. The updated session program will be shown outside of the session room well before the session starts. The chairperson will receive a copy from the assistant.

Venue maps

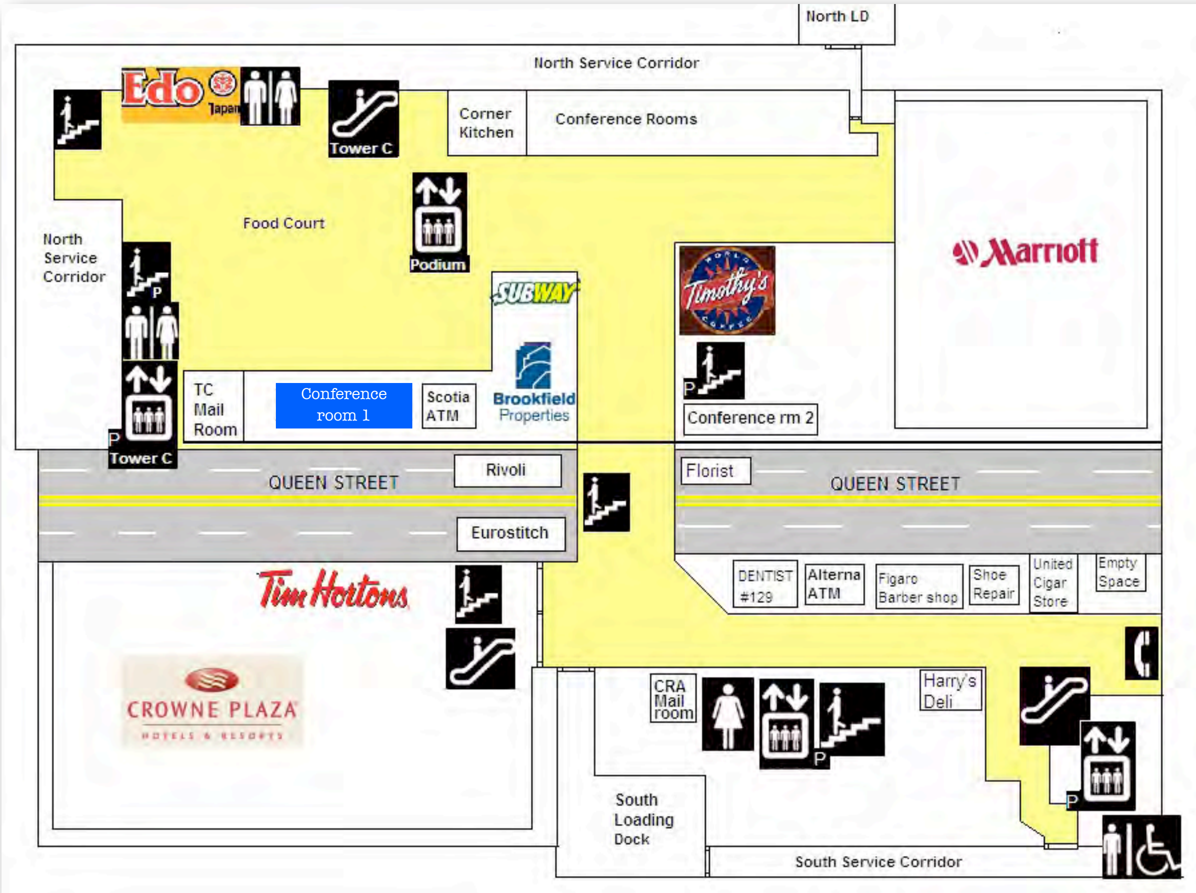
LOWER LOBBY LEVEL
CMOS
SCMO
LLB1
LLT1
LLT2
LLT3
LLT4
LLT5
LLT6
LLT7
ELEVATORS
INTERNATIONAL BALLROOM
LLB2
LLB3
VICTORIA ROOM
LLT8
LLT9
LLT10
LLB4



CHAUDIERE ROOM
JOLIET ROOM
LAURENTIAN ROOM
These three rooms combine to form the Grand Salon
CLT1
CLT2
CLT3
CLT4
ELEVATORS
CONVENTION LEVEL
CAPITALE ROOM
CARTIER ROOM
BYTOWNE ROOM
CMOS
SCMO



Windows
PLB1
PLT1
PLT2
PLT3
PLB2
PENTHOUSE FOYER
South Meeting Room
PINNACLE
North Meeting Room
PANORAMA
ELEVATORS
PENTHOUSE LEVEL
CMOS
SCMO



NOTE: "Conference Room One" in the "Week at a Glance" and session schedules refers to a room located outside the Crowne Plaza but accessible through an underground passageway. The above map shows the location of Conference Room One.

Exhibitors List

Booth/Tables are indicated on the attached Floor Plans on previous pages

Exhibitor	Web link	Booth/Table
Convention Level		
NRC Research Press	http://pubs.nrc-cnrc.gc.ca/eng/home.html	CLT1
WeatherBug Professional	http://weather.weatherbug.com/weatherbug-professional/	CLT2 and CLT3
Taylor & Francis	www.tandf.co.uk/journals/	CLT4
Lower Lobby Level		
ATS Technology Systems Inc	www.atstechnology.ca	LLB1
Campbell Scientific Canada Corp	www.campbellsci.ca	LLB2
Info-Electronics Systems Inc	www.info-electronics.com	LLB3
Vaisala Inc	www.vaisala.com	LLB4
JouBeh Technologies	www.joubeh.com/	LLT1
Fugro Airborne Surveys	www.fugroairborne.com	LLT2
The Canadian Foundation for Climate and Atmospheric Sciences	www.cfcas.org	LLT3
Canadian Meteorological and Oceanographic Society	www.cmos.ca	LLT4
Canadian Geophysical Union	www.cgu-ugc.ca	LLT5
Environment Canada	www.ec.gc.ca	LLT6
ASL Environmental Sciences	www.aslenv.com	LLT7
Integrated Science Data	http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/index-eng.html	LLT8
MDA Corporation	www.mdacorporation.com	LLT9
ECO Canada	www.eco.ca	LLT10
Penthouse Level		
AXYS Technologies Inc	www.axystechnologies.com	PLB1
Hoskin Scientific Ltd	www.hoskin.ca	PLB2
Canadian Broadcasting Corporation	www.cbc.ca	PLT1
RBR LTD	www.rbr-global.com	PLT2
Canadian Network for Detection of Atmospheric Change	www.candac.ca	PLT3

Social Agenda

Banquets

CMOS and CGU will hold separate, but simultaneous, awards banquets on Thursday evening. The CGU Banquet will be held in the Grand Salon of the Crowne Plaza (the Richelieu-Frontenac-Joliet rooms) and the CMOS Banquet will be held in the International Ballroom.

Each full-congress registrant will be provided a ticket to the Banquet appropriate to the choice of social events made during registration. EXTRA tickets for guests can be purchased during on-line registration. A few extra tickets will be available for last-minute purchase at the Congress registration desk but availability may be limited.

Icebreaker

The Congress "Icebreaker" will be held on Monday evening, May 31st between 18:00 and 22:00. The venue will be the Pinnacle/ Panorama rooms on the penthouse floor of the Crowne Plaza hotel. The ceiling-to-floor windows sport a dramatic view of downtown Ottawa, the Ottawa River, and the Gatineau hills. Refreshments will be available, and hot and cold canapés will be served throughout the evening. Areas will be available for mingling, for listening to live jazz and for quiet conversation with colleagues and friends. Music will be provided in the Panorama room by the "CMC Jazz Ensemble", a four-man combo from Montreal.

Each full-congress registrant will be provided a ticket to the Icebreaker. EXTRA tickets for guests can be purchased during on-line registration. A few extra tickets will be available for last-minute purchase at the Congress registration desk but availability may be limited. The "Icebreaker" promises to be a spectacular kick-off event for our Congress in Ottawa. A great opportunity to renew old acquaintances, meet new friends, and get in the mood for an exciting and stimulating Congress week!!

Mysak Luncheon

At noon, on Tuesday, a special luncheon will be held in Ballroom B in honour of Professor Lawrence A. Mysak. Tickets to this special event should be selected, at additional cost, as part of the registration process.

Patterson-Parsons Luncheon

At noon on Wednesday, CMOS will host the Patterson-Parsons Luncheon in the International Ballroom. The Patterson Distinguished Service Medal is presented annually by the Meteorological Service of Canada for distinguished service to meteorology in Canada. The Timothy R. Parsons Award for Excellence in Ocean Sciences is awarded annually by Fisheries and Oceans Canada to recognize a Canadian scientist for outstanding lifetime contributions to multidisciplinary facets of ocean sciences or for a recent exceptional achievement, while working within a Canadian institution.

CGU Barbecue

At noon on Wednesday, CGU will host an informal barbecue on the Terrace, where CGU members can congregate to make new friendships and renew old ones.

A ticket to either the Patterson-Parsons Luncheon or the CGU Barbecue is included with each full-congress registration. Registrants should select which one of these events they wish to attend as part of the registration process. EXTRA tickets for guests can be purchased during on-line registration. A few extra tickets will be available for last-minute purchase at the Congress registration desk but availability may be limited.

Public Lecture

Our Melting Poles: Where Life on Earth is Changing

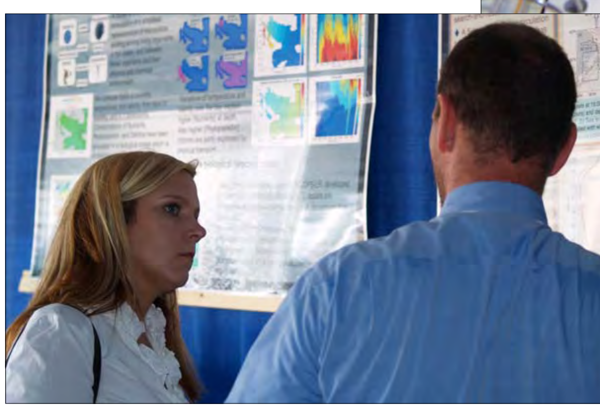
The Arctic and maritime Antarctica are currently warming much faster than the rest of the world, and this trend is expected to accelerate over the course of the 21st century. Already there are ecological signs of change in both polar regions, with alterations of habitat, species distribution and food webs. This talk addresses the questions: how are Earth's polar ecosystems changing, and toward what new state?

Professor Warwick F. Vincent is an internationally distinguished scientist who studies how life at the base of aquatic food webs responds to environmental change. Originally from New Zealand, he and his family arrived in Québec City almost 20 years ago. He now holds the Canada Research Chair in Aquatic Ecosystem Studies at Université Laval and is Director of the inter-university research and training institute, Centre d'études nordiques (CEN: Centre for Northern Studies), also based at Université Laval. A past president of Canada's National Antarctic Committee, a founding member of ArcticNet and recent group chair of NSERC's grant selection committees in the environmental sciences, he has earned numerous honours for his contributions to research and education. These awards include the Canadian Rigler Prize in Limnology, the New Zealand Gold Medal in Science, and the Royal Society of Canada's Miroslaw Romanowski Medal for achievements in environmental research.

Time & Place: 8:00 pm, Wednesday June 2
Crowne Plaza Hotel - Main Ballroom

Introduction to the Media

A Workshop for Researchers



Veteran science reporter Peter Calamai deciphers the inner workings of the media – and the culture of journalists – to help scientists communicate better with the media. Practical tips will be offered on working with reporters at different comfort levels in science, avoiding common mistakes in interviews and dealing with the special demands of TV.

Thursday, June 3rd, 5:30 p.m.—6:30 p.m.

For information, see Kelly Crowe at the booth of the Canadian Foundation for Climate and Atmospheric Sciences.

Teachers' Day

At this year's Teachers' Day (June 3), six presenters will provide teachers with valuable information on various scientific fields and education programs. Some of the presenters, who are experts in their respective fields and represent the principal interests of CMOS and CGU, will provide the teachers with up-to-date information on their scientific fields from a Canadian perspective. Other speakers will provide information about in-classroom activities that teachers can immediately put to use. Members of the two societies have been extremely generous in sourcing and donating material for the kit each teacher participant will receive. CMOS has held a one-day Teachers' Day event -- for educators of Kindergarteners to Grade 12 students -- as part of the annual Congress for several years now. Teachers' Day 2010 is being held at no charge to the participating teachers. CMOS feels a responsibility to encourage enthusiasm and awareness for the atmospheric and oceanic sciences among school-age students. This year we are pleased to be partnering with the CGU and teachers will have a geoscience presentation. By attending this event, teachers are able to act as multiplier points helping to ensure that today's students are exposed to the geophysical sciences.

Presentations:

"Climate Change: Are You Confused?"
Dr. John Stone, Research Professor, Dept. of Geography and Environmental Studies, Carleton University

"Moving Day in Canada - earthquake science and human impact"
Stella Heenan, POLARIS Consortium

"eCards - eLearning on our Changing Climate"
Gordon Harrison, Director, GreenLearning Canada

"What's really happening to Arctic sea ice?"
Doug Bancroft, Director, Canadian Ice Service, Environment Canada

"Environmental Video Conferencing"
René Brunet, Distance Learning & Videoconference Coordinator / Facilitator
La Biosphère, Environment Canada

"Weather - Everywhere and Everyday"
Phil Chadwick, Meteorologist, Environment Canada

Plenary Speakers

Dr. John Adams - Geological Survey of Canada, Natural Resources Canada

John graduated with a PhD in Geology from Victoria University of Wellington, New Zealand in 1978. He has been employed by the Geological Survey of Canada for 29 years, and has been involved with all aspects of the earthquake program, from running field aftershock surveys to managing the program and from creating national seismic hazard maps to participating in post-earthquake engineering reconnaissance visits. John's research interests include the seismotectonics of Canadian earthquakes, evidence for paleo-earthquakes, and the crustal stresses driving the neotectonics and geomorphology, and how these can, and can not, be used for improving seismic hazard estimates.
John has been the lead seismologist in the development of the seismic hazard maps used in the latest edition of the National Building Code of Canada. In addition, he provides general advice on seismic hazards, participates in the Canadian Standing Committee on Earthquake Design for input into the earthquake provisions of the next building code, and participates in various Canadian Standards Association committees dealing with earthquake provisions to critical structures such as nuclear power plants. He is involved with the regulatory assessment of seismic hazard reports for important facilities, such as nuclear power plants, LNG plants, dams, and pipelines, and has completed a screening analysis for Canadian embassies abroad. John is currently treasurer of the Canadian Association for Earthquake Engineering.

Dr. Michel Béland, Environment Canada, Meteorological Service of Canada

Dr. Michel Béland obtained his Ph.D. in Meteorology at McGill University in 1977, in the field of atmospheric dynamics and numerical weather prediction. From January 1973 until his retirement in July 2008, Dr. Béland has been employed by Environment Canada (EC), where he worked, first as a meteorologist, and later as a research scientist in the field of predictability and global atmospheric modeling, and finally later on as a research manager, eventually being appointed Director General, Atmospheric Science and Technology. He also took on three sabbaticals, two of those at the Laboratoire de Météorologie Dynamique in Paris, and one as President and Director General of CERCA, the center for research in applied computation. He was rehired on a part-time basis by his former employer in September 2008, and is presently advisor to the new Director General of Atmospheric Science and Technology. His main task is to fulfill a number of international obligations, the main one being leadership of the Commission of Atmospheric Sciences of the World Meteorological Organization, for which he will complete his first 4-year term in November 2009. He has also chaired the

International Core Steering Committee of THORPEX, a global atmospheric research program, since its inception in 2003, until April 2007; he is also presently co-chair of the International Joint Committee for the 2007-2009 International Polar Year until its eventual dismissal at the Oslo international polar science conference in June 2010. He is a past President (1995) of the Canadian Meteorological and Oceanographic Society (CMOS). He was recently awarded the Patterson Medal from the MSC for distinguished service to meteorology, and is a fellow of CMOS. Dr. Béland's recent contributions to science have been in the field of environmental prediction and seamless modeling. He has been pushing this concept within EC, in some occasions in partnerships with OGD's, and more recently at the international level, where the Executive Council of WMO recently endorsed the recommendations of an international expert panel he contributed in setting up on this concept. He is now tasked with providing the path forward for the eventual operationalization of these concepts by National Meteorological or Hydrometeorological Services's (NMHS's) or their equivalents, focusing on the necessary upstream R&D efforts which will be needed across a number of scientific disciplines.

Prof. Marianne Douglas, University of Alberta Marianne Douglas is the Director of the Canadian Circumpolar Institute and a professor in the Department of Earth and Atmospheric Sciences at the University of Alberta in Edmonton. Interested in natural history and the links between biology and geology, she completed her university degrees in biology at Queen's University, interspersed with a formative term in Paris prior to obtaining her graduate degrees. After completing her PhD in 1993, she worked as a research associate at the University of Massachusetts, Amherst in the Geosciences Department for two years before taking up a faculty position in the Department of Geology, University of Toronto. In Toronto she set up the Paleoenvironmental Assessment Lab and she was awarded a Canada Research Chair in Global Change in 2005. In 2006 she moved to the University of Alberta and currently lives in both Edmonton, AB and Whitehorse, YT. Her research focuses on the study of environmental change in polar regions. Most of her work has been conducted in the Canadian High Arctic, north of the Canadian mainland, along with some field seasons in Antarctica. Using paleolimnological techniques, i.e., the study of lake sediments, it is possible to reconstruct past environmental conditions and events by examining the microfossils and other proxy indicators embedded within the sediments. Most of her work has used algal bioindicators such as the siliceous unicellular diatoms, to identify past changes. Paleolimnological studies on Ellesmere Island identified unprecedented changes in freshwater environmental conditions within the past century and long-term neo-limnological studies showed that these trends were continuing at remarkably high rates, with some ponds reaching complete desiccation. Complementary data is tracking a lengthening growing season that is affecting ecosystems at these high latitudes.

Dr. Richard A. Feely, NOAA Pacific Marine Environmental Laboratory

Dr. Richard A. Feely is a Senior Scientist at the NOAA Pacific Marine Environmental Laboratory in Seattle. He also holds an affiliate full professor faculty position at the University of Washington School of Oceanography. His major research areas are carbon cycling in the oceans and ocean acidification processes. He received a B. A. in chemistry from the University of St. Thomas, in St Paul, Minnesota in 1969. He then went onto Texas A&M University where he received both an M. S. degree in 1971 and a Ph. D. degree in 1974. Both of his post-graduate degrees were in chemical oceanography. He is the co-chair of the U. S. CLIVAR/CO2 Repeat Hydrography Program. He is also a member of the U. S. Science Steering Committees for the U. S. Carbon Cycle Science Program, the U. S. Ocean Carbon and Climate Change Program, and the U. S. Carbon and Biochemistry Program. He is a member of the American Geophysical Union, the American Association for the Advancement of Science and the Oceanography Society. Dr. Feely has authored more than 175 refereed research publications. He was awarded the Department of Commerce Gold Award in 2006 for his pioneering research on ocean acidification. In 2007, Dr. Feely was elected to be a Fellow of the American Geophysical Union.

Dr. Howard Freeland, Institute of Ocean Sciences

Howard Freeland is a senior research scientist in the Ocean Science Division at the Institute of Ocean Sciences, Fisheries and Oceans Canada, in North Saanich, BC. Howard received his BA from the University of Essex (1968) and his PhD in Physical Oceanography at Dalhousie University (1973). He then spent two years as a Post Doctoral Fellow at the Woods Hole Oceanographic Institute and two years as an Assistant Professor at the University of Rhode Island before returning to Canada in 1977. Howard's research has mainly focussed on understanding the dynamics of the oceans, from the way shelf waves are generated and propagate information to the exchange of abyssal waters between the north and south Pacific Ocean Basins to large scale trends and evolution in Pacific abyssal waters, the Sea of Okhotsk and the Gulf of Alaska. But periodically in his career he has kept returning to the problems of doing oceanography from a Lagrangian perspective.

During the last 10 years Howard has primarily been preoccupied with the creation of Argo, the global ocean climate observatory. Howard crossed Canada as the CMOS tour speaker in 2001 with a talk entitled "Launching the Argo Armada". At that time Argo was little more than a dream and the international Argo steering team included representatives of only 8 nations, but Howard predicted in that talk that "we will have a global array of 3000 floats operating in the oceans of the world by some time in 2007". This was actually achieved in November 2007.

Howard is co-Chairman of the international Argo consortium which now includes 26 nations, and also heads the Canadian Argo group.

Dr. Michael G. Sideris, University of Calgary

Dr. Michael G. Sideris has degrees in Geomatics Engineering from the National Technical University of Athens, Greece (1981, Dipl.-Ing., Honours), and the University of Calgary (U of C), Canada (1984, MSc and 1988, PhD). In 2004, he was also awarded an honorary doctorate (Dr. honoris causa) in geodesy by the University of Architecture, Civil Engineering and Geodesy in Sofia, Bulgaria. After receiving his PhD, he joined the faculty of the Department of Geomatics Engineering at U of C, where he is now a professor, as well as Associate Dean in the Faculty of Graduate Studies at the University of Calgary. His research interests are in the areas of gravity field approximation, spatial and temporal geoid modeling, dedicated gravity satellite missions (CHAMP, GRACE, GOCE), satellite altimetry, airborne gravimetry, height systems and vertical datums, optimization, and geodetic applications of statistical, spectral, and wavelet methods. His research on efficient methods for precise geoid determination and geodetic boundary value problem solutions has earned him an international reputation, and the FFT-based software he developed is being used internationally by universities, national agencies and private industry. He has graduated over 30 MSc and PhD students, and has published over 160 articles in scientific journals and fully-refereed conference proceedings. Dr. Sideris is a Humboldt International Research Fellow, and a Fellow of the International Association of Geodesy (IAG) and the International Geoid Service (IGeS). He is currently the President of the IAG and a member of the Executive Committee of the International Union of Geodesy and Geophysics (IUGG).

Dr. Laurence Smith, University of California, Los Angeles

Laurence C. Smith is Professor and Vice-Chair of Geography and Professor of Earth & Space Sciences at the University of California, Los Angeles (UCLA). He received a B. S. in Geological Sciences from the University of Illinois at Urbana-Champaign (1989), M. S. in Geological Sciences from Indiana University (1991), and Ph. D. in Earth & Atmospheric Sciences from Cornell University (1996). His research interests broadly span water and carbon cycles in the cryosphere and remote sensing, with studies of northern river hydrology, glaciers and ice sheets, the effects of permafrost thaw on soil carbon and lakes, and synthetic aperture radar and lidar systems. In 2006 he briefed Capitol Hill on the likely impacts of Arctic climate change and in 2007 his research on disappearing Siberian lakes appeared prominently in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4). In 2006-2007 he was named a Guggenheim Fellow by the John S. Guggenheim Foundation in New York. Other honors include a NASA Young Investigator award (2000), NASA Finalist for the Presidential Early Career Award (2002), Discover Magazine's "Top 100 Science Stories" (2006); and a Bellagio Residency from the John D. Rockefeller Foundation (2007). He is currently writing a popular-science book THE NEW NORTH: Our World in 2050 (Dutton, Penguin Group and others) to be published in 2010.

Dr. Susan Solomon, National Oceanic and Atmospheric Administration Susan Solomon is widely recognized as one of the leaders in the field of atmospheric science. Since receiving her PhD degree in chemistry from the University of California at Berkeley in 1981, she has been employed by the National Oceanic and Atmospheric Administration as a research scientist. Her scientific papers have provided not only key measurements but also theoretical understanding regarding ozone destruction, especially the role of surface chemistry. In 1986 and 1987, she served as the Head Project Scientist of the National Ozone Expedition at McMurdo Station, Antarctica and made some of the first measurements there that pointed towards chlorofluorocarbons as the cause of the ozone hole. In 1994, an Antarctic glacier was named in her honor in recognition of that work. In March of 2000, she received the National Medal of Science, the United States' highest scientific honor, for "key insights in explaining the cause of the Antarctic ozone hole." She is the recipient of many other honors and awards, including the highest awards of the American Geophysical Union (the Bowie Medal), the American Meteorological Society (the Rossby Medal), and the Geochemical Society (the Goldschmidt Medal). She is also a recipient of the Commonwealth Prize and the Lemaitre Prize, as well as the ozone award and Vienna Convention Award from the United Nations Environment Programme. In 1992, R&D magazine honored her as its "scientist of the year". In 2004 she received the prestigious Blue Planet Prize for "pioneering research identifying the causative mechanisms producing the Antarctic ozone hole." She is a recipient of numerous honorary doctoral degrees from universities in the US and abroad. She is a member of the U. S. National Academy of Sciences, the American Philosophical Society, and is a Foreign Associate of the French Academy of Sciences, the Royal Society, the Royal Society of Chemistry, and the European Academy of Sciences. Her current research includes climate change and ozone depletion. She served as co-chair of the Working Group 1 Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC, 2007), providing scientific information to the United Nations Framework Convention on Climate Change. IPCC and Albert Gore, Jr jointly received the Nobel Peace Prize in 2007. She was named one of the year's 100 most influential people in Time magazine in 2008. She also received the Grande Medaille of the Academy of Sciences in Paris for her leadership in ozone and climate science in 2008, and the Volvo Environment Prize in 2009.

Scientific Sessions Description

ATMOSPHERE

General Atmospheric Sciences

Doug Whelpdale - EC/ Science and Technology Branch
Contact: douglas.whelpdale@ec.gc.ca

This session will consist of contributions related to atmospheric science that are not part of more specialized sessions. Topics of interest include meteorological analyses of notable wind and precipitation events, data assimilation in numerical forecasting systems, operational aspects of meteorological forecasting.

Cloud-Aerosol Interactions

Philip Austin - Department of Earth and Ocean Sciences, University of British Columbia
Jonathan Abbatt - Department of Chemistry, University of Toronto
Knut Von Salzen - Canadian Center for Climate Modeling and Analysis, Environment Canada
Howard Barker - Cloud Physics and Severe Weather Research, Environment Canada
Contact: paustin@eos.ubc.ca

Atmospheric aerosols play a major role in determining the physical properties of clouds, and in turn are modified by cloud processes through precipitation scavenging and aqueous phase chemistry. Understanding this coupled behaviour is important for estimating both the current radiative impact of clouds and aerosols on climate, and the sensitivity of the climate to changes in clouds and aerosols given a warming planet. This session will highlight new work in satellite observations, experimental studies and global, regional and small scale modeling of clouds and aerosols.
Example topics could include:
1) cloud-aerosol measurements from A-train satellites (Aqua, Cloudsat, CALIPSO)
2) Global and regional modeling studies of clouds and aerosols, including results from the CFCAS Cloud-Aerosol Feedbacks and Climate network and GEWEX Cloud System Studies intercomparisons.
3) Field and experimental measurements of cloud condensation nuclei, aerosol activation and droplet growth.

Air Quality and Atmospheric Chemistry from Space to the Boundary Layer

Jack McConnell - York University
Contact: jack@nimbus.yorku.ca

Measurements of atmospheric composition from space are becoming increasingly important in providing a global view on changing atmospheric composition both from the perspective of air quality and also climate. They provide a larger perspective than can be obtained from ground stations or aircraft. In the Visible and NIR nadir viewing instruments such as SCHIAMACHY, GOME etc can measure columns of tropospheric and stratospheric species while in the Mid-IR instruments such as MOPITT measure partial columns of CO. Limb viewing instruments such as the ACE-FTS, MAESTRO, MIPAS, OSIRIS, provide height resolved measurements of air quality and climate gases and aerosols down into the upper troposphere. Also imaging instruments such as MODIS, MERIS as well as providing land use and surface temperature data also can provide Boreal fire data as well as aerosol optical depths as well as aerosol properties in the case of MERIS. This data is nicely complemented by the AERONET/AEROCAN networks along with the EC CORAL network. We invite researchers who are pursuing air quality studies in the troposphere and UTLS to present their work particularly those who use satellite data for regional and global air quality, UTLS studies, Fire (biomass burning) studies, and the 6 APPOC studies, PCW to present. In addition modelling and chemical data assimilation studies and comparisons of ground based and satellite data are encouraged with a view to emphasizing, if possible, the synergy of groundbased, aircraft and satellite measurements.

The upper troposphere and lower stratosphere (UTLS)

Michel Bourqui - McGill University
David Tarasick - Environment Canada
Contact: michel.bourqui@mcgill.ca

The upper troposphere and lower stratosphere (UTLS) is a key region in the atmosphere, regulating the exchange between the stratosphere and the troposphere. It has important implications for the composition of the troposphere and the lower stratosphere and is an area of intense research.

This session welcomes contributions on any aspects relevant to the UTLS, including impacts of stratosphere-troposphere exchange on the atmospheric composition. Studies using observations, such as related to balloon sonde measurement campaigns, or satellites, or a combination of observations and numerical modelling are particularly welcome.

Aviation Meteorology

Stewart Cober - Cloud Physics and Severe Weather Research Section
Contact: stewart.cober@ec.gc.ca

This session would include a series of talks related to aviation meteorology. A broad spectrum of aviation weather related science and service issues could be discussed including: TAF forecasting strategies, HUB airport forecasting, aircraft icing, operational issues, client requirements, new R&D applications, NinJo applications, case studies, and emerging issues. Similar sessions have been quite successful during previous CMOS meetings. I volunteer to organize the entire aviation session, review and organize the abstracts, and find chairs for each of the sub-sessions. I will encourage participants from the government, university and aviation communities to attend.

The Vancouver 2010 Olympic and Paralympic Winter Games

George Isaac, Paul Joe
Cloud Physics and Severe Weather Research Section, Environment Canada
Contact: george.isaac@ec.gc.ca

The Vancouver 2010 Olympic and Paralympic Winter Games represented an excellent opportunity to improve our ability to provide weather forecasts in complex terrain. The issues of measuring critical meteorological parameters such as winds, precipitation, visibility, etc, in mountainous areas were addressed. Several new numerical models and associated methods were developed and evaluated. International efforts such as the Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) and T-Parc (The THORPEX Pacific Asia Regional Campaign) were also conducted in association with the winter Olympics. Submissions are requested on such activities from both the operational and research communities.

Our Roads - Road Weather Service Developments

Paul Delannoy
Contact: paul.delannoy@amec.com

Almost all provincial/territorial governments across Canada now have installed a network of Road Weather Information Systems (RWIS). Since the federal government support program, RWIS Canada, was introduced in 2002, the number of RWIS stations has increased dramatically across the country and now exceeds 400. Private sector firms use RWIS data to prepare forecasts of the pavement surface temperature at the sites which serves as critical guidance to assist winter road maintainers. Such services have proven their worth in increasing motoring safety while reducing salt use and costs. New applications using all of this information are now being devised. These include the use of infra-red imaging to resolve the entire road length between RWIS sites and forecasting the vertical temperature profile below the road to determine precisely when weight restrictions should be applied. Decision aids have been devised to reduce the great volume of complex weather information into something simple to understand and apply by maintenance staffs. Most jurisdictions also use on-board sensors (IR for pavement temp, air temp, and RH) on their patrol vehicles and/or ploughs. Vehicles position and activity is tracked using GPS and cellular communications. New applications are being devised using this real-time information from the entire network. In the US, NCAR, with multi-year funding from the Federal Highways Administration, has developed the Maintenance Decision Support System (MDSS) which integrates diverse weather information and provides guidance products for the entire road network. The rich road weather data sets, most of which are exchanged with EC through RWIS Canada Data Sharing Agreements, will soon be applied to provide yet more practical information to other road communities such as the general motoring public through new innovative services such as dedicated 511 road and weather telephone services. Québec, Nova Scotia, and the Yukon already have 511 services in place.

August 20th 2009 Ontario Tornado Outbreak

Arnold Ashton - Environment Canada
Contact: Arnold.Ashton@ec.gc.ca

The summer of 2009 in Ontario was a near-record tornado season with a total of 27 tornadoes between April and September. There were four fatalities and an unprecedented amount of damage across the province. The culmination was August 20th when a large tornado outbreak spawned 17 tornadoes in Southern Ontario (making it one of the largest recorded tornado outbreaks in Canadian history), causing one fatality and severe damage in several locations. A detailed examination of this event, and comparing it to other severe wind or tornado events, will serve to improve our forecast and warning programs and allow us to share our insights with other forecast centres. A number of talks will be presented. They include a comprehensive analysis of the synoptic weather pattern that day including scrutiny of a number of meteorological parameters deemed important for tornadogenesis (including CAPE, helicity, effective shear). Comparisons will be made with other wind events, including a derecho event which occurred over Southern Ontario, August 9th. Detailed structural analysis of the storms on radar will be presented, including an airborne debris signature near Toronto. The large scale of the August 20th event, and its affect on an urban area provides a rare opportunity for a detailed engineering perspective on tornado damage (by the University of Western Ontario engineering research team). A climatic structural designs perspective will also likely be provided (Adaptation and Impacts Research Division within Environment Canada). A media perspective may also be included to gauge the reactions of Canadians to severe weather warnings. A total of 6 or 7 talks are likely. (As an aside: An 18th Aug 20th tornado is being investigated today, and if it is confirmed, then it will make it the largest tornado outbreak in Ontario (and possibly Canadian) recorded history.

Wind Energy

Peter Taylor - Centre for Research in Earth and Space Science, York University
Jim Salmon - Zephyr North Canada
Contact: pat@yorku.ca

With increasing population and energy consumption, coupled with concerns about climate change, safety and cost issues with nuclear power, and finite oil and gas resources, most counties in the world are planning significant increases in their use of wind and solar power for electricity generation. In Canada the target is an increase from 1% now to 20% by 2030.

The atmosphere plays a central role in these renewable energy resources. Resource assessment and site-specific forecasting (wind and solar radiation for a 24-48 hour time period) are the main areas where meteorology is critical but, for wind energy, the atmosphere also comes into play in issues such as noise propagation and icing hazards. Turbulence and wind shear can cause problems for large wind turbines and wake effects in wind farms need more research.

Ensemble forecasting: current and emerging applications

Bertrand Denis, Lewis Poulin - Canadian Meteorological Center
Contact: lewis.poulin@ec.gc.ca

A session is proposed to discuss how Ensemble Prediction Systems (EPS) are impacting forecasting activities in a surprisingly large number of areas. Presentations are welcome to showcase EPS products, like, for example, probability forecasts, that are increasingly used in planning and risk management activities in sectors like government and commercial weather forecasting, energy supply and demand (including renewable energy), hydrology, search and rescue, forest management operations impacted by fire weather conditions, financial and insurance sectors, government emergency response, and many more. There is interest in showing how increasing our litteracy in EPS forecasting and related products may also assist in developing and adopting strategies in areas of climate change mitigation and adaptation. Presentations are also welcome on EPS models and techniques currently or soon to be available in National and regional weather centers. Presentations on NAEFS (North American Ensemble Forecast System) and other projects based on EPS data will serve to familiarize users with these new types of datasets. The broad scope purposely offered by this session will likely be of interest to the operational weather forecaster but also to forecasters in other sectors also impacted by weather. This session will help you highlight how your use of EPS models and products is re-shaping how we approach forecasting our common future.

CLIMATE

Stratospheric Processes and their Role in Climate

Norman McFarlane - SPARC IPO, University of Toronto
Theodore Shepherd - Department of Physics, University of Toronto
Paul Kushner - Department of Physics, University of Toronto
Saroja Polavarapu - Environment Canada
Contact: Norm.Mcfarlane@ec.gc.ca

This session will focus on topics falling within the scope of the WCRP SPARC (Stratospheric Processes and their Role in Climate) program, including broader cross-cutting topics within the WCRP (World Climate Research Program) that are closely linked to current SPARC activities. The over-arching themes of SPARC are chemistry-climate coupling; stratosphere-troposphere dynamical coupling; and the detection, attribution and prediction of stratospheric change. Core elements of the SPARC program include stratospheric data assimilation; process-oriented validation of chemistry-climate models (CCMVal); gravity waves; stratosphere- troposphere coupled dynamical variability, and laboratory studies. The session will encompass the chemistry and dynamics of the atmosphere from the upper troposphere to the mesosphere, with an emphasis on integrative and coupled aspects including important stratosphere-troposphere coupling processes that affect the climate system and climate change. The session will include several invited oral presentations from the international SPARC community in addition to contributed oral and poster presentations.

Climate Change and Extreme Events

Chad Shouquan Cheng - Environment Canada
Contact: shouquan.cheng@ec.gc.ca

It has become widely recognized that under a changing climate, the frequency of meteorological/hydrological extreme events and associated damage costs would more likely increase in the 21st century. To expand adaptive capacity to minimize future hazardous risks, solid scientific information on future projections of the extreme events is essential for decision makers to develop adaptation strategies and policies. This information includes quantitative assessments on changes in frequency and magnitude of the meteorological and hydrological extreme events under a changing climate. This session invites submissions of papers concerning climate change impacts on meteorological and hydrological extreme events using GCM and RCM outputs and/or statistical downscaled scenarios. Meteorological/hydrological extreme events include (but not limited to) heat, cold, heavy rainfall, flooding, drought, freezing rain, blizzard, wind gust, hurricane, tornado, etc. The purpose of this session is to provide a platform for researchers to share information, exchange latest developments and applications of climate change impacts analyses on the meteorological and hydrological extreme events.

Climate change and the carbon cycle

Nathan Gillett - CCCma, Environment Canada
Kirsten Zickfeld - CCCma, Environment Canada
Damon Matthews - Geography, Planning and Environment, Concordia University
Contact: nathan.gillett@ec.gc.ca

The marine and terrestrial carbon cycles are key determinants of the future level of atmospheric CO2 and hence of future climate change. The global carbon cycle is expected to change in response both to elevated atmospheric CO2 and to changes in climate, and uncertainties in its response are roughly as important as uncertainties in the physical climate system for predictions of 21st century climate change. Interactive terrestrial and ocean carbon cycles have now been incorporated in many state- of-the-art global climate models, including the Canadian model CanESM2, offering powerful new tools to investigate these issues. Recent research has highlighted the irreversibility of CO_2-induced climate change on centennial timescales, the path-independence of CO_2-induced temperature change, and the resulting policy implications. We invite submissions on all aspects of the global carbon cycle and its interactions with climate change.

Low-frequency variability and predictability

Hai Lin, Bin Yu - Environment Canada
Contact: hai.lin@ec.gc.ca

This session invites contributions that deal with climate variability and predictions on intraseasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, teleconnections, air-sea coupling and tropical-extratropical interactions, and impacts of these processes on climate predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modeling, model inter-comparison, and theoretical approaches are all welcome.

Regional Climate Modelling

Laxmi Sushama - University of Quebec at Montreal
René Laprise - University of Quebec at Montreal
Ramon De Elia - Ouranos Consortium
Bernard Dugas - RPN, Environment Canada
Contact: sushama.laxmi@uqam.ca

Regional climate models (RCMs) are increasingly being used for studying climate processes on small scales and for downscaling global climate model (GCM) results to finer spatial resolution. We seek presentations for this session which will provide an overview of the current state of the art in dynamical RCMs and will summarize outstanding issues in the development and application of RCMs. Contributions are solicited on topics including but not limited to regional downscaling of IPCC climate change scenarios, RCM intercomparison projects, design of RCM simulations in light of the needs of climate impacts studies, effects of resolution and physical parameterizations on RCM accuracy, assessment of uncertainty of regional projections, assessment of downscaling skill and added value and skill of RCMs when applied to different regions.

ATMOSPHERE-OCEAN INTERACTIONS

Lawrence Mysak Session on Ocean and Climate Dynamics

William Hsieh - Dept. of Earth and Ocean Sciences, Univ. of British Columbia, Vancouver, BC, V6T 1Z4
Bruno Tremblay - Dept. of Atmospheric and Oceanic Sciences, McGill University, Montreal, QC H3A 2K6
Contact: whsieh@eos.ubc.ca

This is a special session to honour Professor Lawrence Mysak's career achievement. Prof. Mysak's early work was in dynamical oceanography especially on low-frequency wave dynamics and continental shelf processes. Later, he broadened his interests to climate dynamics and modelling of the ocean-ice-atmosphere system, from present day climate variability to paleoclimate. He will remain active in his professional and research activities as an emeritus professor at McGill University. Abstracts are solicited on ocean and climate dynamics, and on all aspects of Mysak's work (oral/poster). The session will be held in conjunction with a luncheon on Tuesday, 1 June, where friends of Prof. Mysak will gather to wish him well for the future (luncheon tickets available at registration).

Atmosphere, Ocean, and Climate Dynamics

Adam Monahan - School of Earth and Ocean Sciences, University of Victoria
Marek Stastna - Department of Applied Mathematics, University of Waterloo
Ron Mctaggart- Cowan- -CMC, Environment Canada
Contact: monahana@uvic.ca

This session combines submissions with a focus on atmosphere, ocean and climate dynamics. The title of the session is deliberately broad in order to allow researchers who concentrate on the study of any aspect of the earth system from a dynamical perspective to be included. Other sessions exist for addressing operational issues, numerical modeling, and the acquisition and use of observations. However, dynamical and diagnostic studies of the atmosphere, ocean and climate systems are often difficult to slot into particular sessions. Theoretical studies and analyses of forecast model, climate model, and reanalysis datasets serve the valuable function of increasing our understanding of the important dynamic and thermodynamic processes that drive circulations across time and spatial scales. A well-organized session that combines studies that approach the field from this angle could be of great benefit to the CMOS community in general.

Atmosphere-Ocean Interactions & Waves

Will Perrie - Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

This session will explore coupled atmosphere-ocean dynamics, and associated extreme waves, storm-induced currents, and storm surges in severe marine storms. Coupling processes will be investigated. For example, in a coupled atmosphere - wave - sea spray - current model system, the effects of sea spray and wave drag have impact on storm-generated waves, their height variations, and directional wave spectra, related to the storm location and translation speed. The decrease or increase of significant wave height due to spray and wave drag is most significant in high wind regions to the right of the storm track. These processes are modulations on the maximum wave region, and tend to occur after the peak wind events, depending on the storm translation velocity. The translational speed of the storm is important. The directional variation between local winds and wind-generated waves within rapidly moving storms that outrun the waves is notably different from that of trapped waves, when the group velocity of the dominant waves approximates the storm translation speed. These processes also have impact on ocean currents and storm surge. The net effect of wind-to-wave and wave-to-current momentum transfers reduces the surface current speeds. Other aspects of atmosphere-ocean coupled systems, including simulations of marine storms are welcome.

Coupled Atmosphere-Ocean Prediction and Predictability

Keith Thompson - Dalhousie University
Hal Ritchie - Environment Canada/Dalhousie University
William Merryfield - Environment Canada/University of Victoria
Contact: psc@cmos.ca

There is growing scientific interest in improving and extending the prediction skill of coupled models of the atmosphere-ocean land-sea ice system on time scales of days to decades. It is generally recognized that this requires the development of coupled atmosphere-ocean modelling and assimilation systems although initialization of land and sea ice also present challenges and opportunities and are gaining increasing attention. Progress hinges on developing methods to assimilate observations into coupled models, and identifying and understanding the physical processes that limit and provide predictability. All interested scientists are invited to submit presentations on scientific, modelling and assimilation issues related to prediction and predictability of the coupled atmosphere-ocean-land-sea ice system.

When the atmosphere and the ocean get along over the Gulf of St. Lawrence

Serge Desjardins - National Lab for Marine and Coastal Meteorology, EC,Dartmouth
Contact: serge.desjardins@ec.gc.ca

For over a decade, the Gulf of St. Lawrence has been the subject of studies aimed at understanding and modeling of the atmosphere-ocean interaction. The Gulf of St. Lawrence coupled forecasting system in Environment Canada is an example of the scientific benefits of such research and development. This system is the result of collaborations between different R & D groups: Institut Maurice Lamontagne (IML), Numerical Prediction Research, Canadian Meteorological Center (CMC), UQAR, Canadian Ice Service, etc. Its development over the years has resulted in R & D such as the inclusion of ice in wave forecasts and data assimilation of ice. Finally, it is often seen as the first step taken in the development of more complex coupled multiscale systems like CONCEPTS.

This session will focus on meteorological and oceanographic studies done in a coupled or uncoupled mode, and any other related research fields such as the forecasting of waves, ice, and data assimilation in the Gulf of St. Lawrence region.

We dedicate this session to Dr. François Saucier who, by the development of the IML ocean model and his physical oceanography studies of the region, fostered the development of the atmosphere-ocean coupled modeling of the Gulf of St. Lawrence.

OCEANOGRAPHY

Oceanography General Session

Guoqi Han - Fisheries and Oceans Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

This session will consist of contributions related to oceanographic sciences that will not fit appropriately into the other oceanographic sessions.

Acoustics in Oceanography

Tetjana Ross - Dalhousie University
Contact: tetjana@dal.ca

The focus of this session is to highlight the contributions of underwater acoustics to oceanography. This includes, but is not limited to: sonar and passive acoustics, bio-acoustics, geological structure in the ocean bottom, acoustic communication, naval applications, ambient noise, long-range propagation, high-frequency scattering, imaging and quantitative inversion.

Operational Oceanography: observations, modelling and data assimilation
Greg Smith - Environment Canada
Denis Gilbert - Fisheries and Ocean Canada
Fraser Davidson - Fisheries and Ocean Canada
Howard Freeland - Fisheries and Ocean Canada
Contact: Gregory.Smith@ec.gc.ca

Operational oceanography involves the transformation of individual observations of the ocean into useful, routine (not always real-time) analyses and forecasts of the state of the ocean. To produce useful analyses we need observations, models and data assimilation systems. This session welcomes posters and talks on all aspects of operational oceanography from the analysis of observing systems such as Argo and satellites, to ocean modelling and data assimilation. Additionally, papers on the practical applications of ocean forecast systems including coupled atmosphere, ocean and ice forecast systems are encouraged.

Ocean Observatories: Online and Operational
Richard Dewey - VENUS, UVic
Mairi Best - NEPTUNE Canada, UVic
Contact: rdewey@uvic.ca

The session will focus on the new science, engineering, education and outreach opportunities provided by ocean observatories. Canada is leading the world in this new paradigm of conducting real-time interactive ocean research on both VENUS and NEPTUNE, cabled ocean observatories off the west coast of Canada. Other observatories in the Arctic, on the St. Lawrence, and in the Maritimes have also demonstrated Canada's expertise and innovation on a variety of networked platforms. International initiatives to build ocean observatories in the USA, Europe, and Asia are also on-going. Presentations are encouraged related to all aspects of ocean observatory research, including process oriented studies, long-term monitoring, modelling and data assimilation, engineering solutions, networked instruments, data handling, and operational product distribution.

Coastal Oceanography and Inland Waters
Ram Rr Yerubandi - Environment Canada/NWRI
Jinyu Sheng - Dalhousie University
Guoqi Han - Dept. of Fisheries and Oceans
Contact: ram.yerubandi@ec.gc.ca

This session will focus on all aspects of monitoring and modelling of physical and biogeochemical processes in coastal domains, shelf seas, estuaries and inland waters. Topics include but are not limited to coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, mixing and dispersion of materials. We also invite contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters.

Ocean Climate Change, Variability and Impacts
John Loder - Fisheries and Oceans Canada, Bedford Institute of Oceanography
Ken Denman - Fisheries and Oceans Canada, Institute of Ocean Sciences
Mike Foreman - Fisheries and Oceans Canada, Institute of Ocean Sciences
Contact: John.Loder@dfo-mpo.gc.ca

The ocean is a major component of the Earth's climate system. Change and variability in ocean climate can have important global and regional influences on marine ecosystems, coastal populations and marine activities. This session will focus on recent change (trends) and variability (fluctuations) and their associated impacts on Canadian oceans, and on projected or potential future change, variability and impacts. These impacts can include effects on regional or global climate systems, coastal ocean climate, marine ecosystems, coastal zones, and/or various activities involving the ocean. Presentations on all three of the oceans surrounding Canada are welcome, although it is anticipated that (at least) some papers on Arctic climate change will contribute to other sessions so that the primary focus of this session may be the Northeast Pacific and Northwest Atlantic Oceans. Presentations on studies describing, understanding and predicting change, variability and impacts related to physical and biogeochemical aspects of ocean climate are encouraged.

Remote Sensing of the Oceans
Gary Borstad, Howard Edel - ASL Environmental Sciences
Contact: edel@dfo-mpo.gc.ca

Remote sensing of the vast Canadian coastal zone and oceans areas continues to mature into operational applications as sensors and data processing systems converge to provide quantitative, timely and cost effective marine information services. A combination of methods including remote sensing data use in models can provide detailed now-casting and enhanced forecasting capabilities. The surveillance and monitoring of the large Canadian EEZ area are being enhanced with the wide variety of remote sensing systems. The Canadian RADARSAT 1 & 2 programs are dedicated to providing a space based sensor system addressing the unique polar monitoring needs important to northern development and enhanced and safe access to enhance northern economic development and exercise of Canadian Sovereignty. This session will review active and passive sensor systems which marine climatologists and operational users are utilizing for coastal zone, and marine environmental monitoring as well as vessel surveillance in the Canadian exclusive economic zone.

Ocean Biogeochemistry Responses to Environmental Change
Helen Joseph, Paul Lyon - DFO
Contact: Helen.Joseph@dfo-mpo.gc.ca

Global, regional and local environmental change are having profound socio-economic consequences. Ocean acidification, fertilization, eutrophication, hypoxia, etc. can potentially alter community structures and food webs in the coastal and open ocean, and as a result, degrade and damage ecosystems and fisheries. Biogeochemical papers are encouraged to be submitted in this session that describe field observations, laboratory experiments, paleo-oceanographic studies and model studies in high latitude oceans.

INTERDISCIPLINARY
Health Issues of Weather and Climate
Denis Bourque - Environment Canada
Contact: denis.bourque@ec.gc.ca

Sessions under this theme provide an opportunity to present original work concerning the relationship of weather or climate with human health, including material which could address Climate / Climate Change and Health Issues; Weather and Health issues; Operational Weather-based Health Products & Programs; and papers/research which address the policy and economic aspects of weather and climate on health issues. We are seeking original work studying the relationship(s) between human health (mental and physical) or society's health systems with current and future climates, or studying the relationship(s) between human health (mental and physical) or society's health system with current or future day-to-day weather. We also welcome papers concerning operational-style weather-based health products, such as wind chill indices and heat indices, or services, such as the UK Met Office Chronic Obstructive Pulmonary Disease (COPD) program. Weather-related studies of vector-borne human diseases or their carriers, such as ticks (Lyme disease) and mosquitoes (West Nile Virus), or bacteria, such as outbreaks of E. coli 0157: H7, Campylobacter and Cryptosporidium, are also welcome.

Weather and Society - Integrated Studies

Jacques Descurieux, Rebecca Wagner - Environment Canada/Meteorological Service of Canada
Contact: jacques.descurieux@ec.gc.ca

This session aims at bringing together practitioners, researchers, and stakeholders, in all sectors of the weather enterprise, who are dedicated to the integration of meteorology and social science. It is a forum that facilitates the comprehensive and sustainable integration of social science into meteorological research and practice. The objective is to provide the meteorological community with a means to learn about and further examine ideas, methods, and examples related to integrated weather-society work.

This session invites papers exploring new approaches to study weather, climate, and their relationship with society. This includes, but is not limited to: • Qualitative and quantitative methodologies for improving understanding, communication, and use of weather and climate information • Mixed methods and comparative qualitative impact studies • Risk and crisis communication issues relating to hazardous weather • Communicating uncertainty and forecasts • Issues of risk and choice perception relating to hazardous weather • Intersections of warnings, response and emergency management • Research in mitigation, preparedness, and sustainability

Water, weather, and climate serving the energy sector

Anne-Marie Valton - Environment Canada
Contact: anne-marie.valton@ec.gc.ca

Energy is becoming a very important issue as much as climate change and water. There is a need worldwide to address this issue in the context of a changing climate: we need to find ways to manage energy demand and supply more efficiently. Environmental prediction in water and atmospheric science can address directly these important priorities by helping the decision makers to improve management of energy resources. They also help to match energy supply and demand and to better manage risk to energy infrastructure. They can also improve inventories of greenhouse gases and evaluate renewable energy potential. Environmental predictions can improve the competitiveness & leadership of a clean energy system. As Canada is among one of the world's largest producers of most types of energy, it is important to support this sector and see how we can help decision makers in this area.

Environmental Prediction in Canadian Cities

James Voogt - University of Western Ontario
Tim Oke - University of British Columbia
Contact: javoogt@uwo.ca

This session is intended to highlight results from the CFCAS Network project - Environmental Prediction in Canadian Cities

(EPiCC). The EPiCC network celebrates four years of research in July 2010 so the timing of this CMOS meeting will allow EPiCC Network members to provide attendees with results from the main aspects of the EPiCC project. These include long term energy balance and carbon flux observations from four urban residential areas in Montréal and Vancouver, together with shorter campaigns to examine the role of snow cover and irrigation in Montréal and Vancouver, respectively. The primary focus is on the residential areas of cities that constitute a large fraction of urban areas and which combine the influence of the built environment with significant amounts of vegetation. Surface observations are complemented with analyses of ceilometer, lidar and balloon-borne instrument observations of the Vancouver urban boundary layer to better understand its evolution in space and time. The objective of the modeling work in EPiCC is to provide an urban surface parameterization suitable for inclusion in the MSC forecast system to provide better urban weather forecasts for Canadians. The modeling component is developing an urban surface parameterization scheme based on the Town Energy Balance (TEB) model of Masson (2000). TEB has been modified from its original form to properly represent the conditions experienced in Canadian cities. The revised model is being evaluated against the EPiCC observational data set. We expect researchers from the EPiCC network will provide 6-8 presentations describing results from EPiCC that are and representative of the mix of observational, modeling and remote sensing work undertaken by the network. If desired, the session could be broadened to include other work related to urban climate.

Micrometeorology of Canadian Ecosystems

Paul Bartlett - Climate Research Division, Environment Canada
Elyn Humphreys - Department of Geography and Environmental Studies, Carleton University
David Spittlehouse - Research Branch, British Columbia Ministry of Forests and Range
Ralf Staebler - Air Quality Research Division, Environment Canada
Jon Warland - School of Environmental Sciences, University of Guelph
John Wilson - Department of Earth and Atmospheric Sciences, University of Alberta
Contact: Paul.Bartlettt@ec.gc.ca

The Canadian landscape contains a variety of ecosystems, which are usually characterised by their surface cover. Micrometeorological studies are conducted in an effort to quantify and understand the factors and processes controlling surface-atmosphere exchanges of radiation, energy, water and carbon. In this session, sponsored by the Canadian Society of Agricultural and Forest Meteorology, research involving the measurement or modelling of surface-atmosphere interaction in Canadian ecosystems will be presented, including but not limited to agricultural lands, forests, wetlands, grasslands, sub-Arctic and Arctic tundra.

Drought, Climate and Society

Ronald Stewart - University of Manitoba
John Pomeroy - University of Saskatchewan
Richard Lawford - University of Manitoba
Contact: ronald_stewart@umanitoba.ca

The occurrence of drought is a ubiquitous feature of the global water cycle. Droughts are recurring aspects of weather and climate extremes as are floods and tornadoes, but they differ substantially since they have long durations and lack easily identified onsets and terminations. Drought is a relatively common feature of the North American and Canadian climate system and all regions of the continent are affected from time-to-time.

However, it tends to be most common and severe over the central regions of the continent; the Canadian Prairies are therefore particularly prone to drought. The possible increase in drought is one of the greatest concerns associated with climate change.

This Session features drought research from Canada and from all parts of the world. The Session encourages contributions on the definition, characterization, trends, and understanding of drought; the role of drought in the climate system; drought prediction at various time scales including those associated with climate change; as well as drought impacts and society's preparedness for drought. Submissions are welcome from the Drought Research Initiative community and from all other investigators of drought phenomena.

Physical-Biological Interactions in the Aquatic Environments

Tetjana Ross - Dalhousie University
Contact: tetjana@dal.ca

Embracing interdisciplinarity has been key to many of the most important advances in oceanography and limnology over the past 40 years. This session encourages contributions that cross disciplines between physical oceanography/limnology, which has long been well represented at CMOS congresses, and biology or biogeochemistry. From dissipation scales to basin scales, research conducted in the field, laboratory or computer model are welcome.

“Today, one can scarcely conceive of an oceanographic question that does not cut across disciplines.” - Thomas M. Powell (Oceanography, September 2008)

Weather and Climate Monitoring in Canada - Current operations and future directions

Mike Manore, Dave Wartman, Al Pietroniro, Jim Abraham - EC - Meteorological Service of Canada
Contact: mike.manore@ec.gc.ca

Observations are the foundation for all meteorological and hydrological information, research, and services. The effort to establish relevant monitoring networks is substantial, and sustainably operating these systems presents significant scientific, operational and financial challenges. These include providing representative observations of Canada's vast, harsh, and often remote environment, ever-growing user requirements, and adapting to constantly-evolving technologies. The goal of this session is to explore the current and evolving practices in weather and climate monitoring, and to stimulate discussion on the future of Canada's observation networks. The Session is composed of four sub-sessions on: • Monitoring Network Operations • Instrumentation and Technology • Space-based Monitoring • Strategic Directions for Monitoring The last sub-session will include three papers, followed by an audience-driven discussion panel on the strategic directions for meteorological, hydrometric, and climate monitoring in Canada.

CFCAS Achievements - The First Decade

Dawn Conway - Canadian Foundation for Climate and Atmospheric Sciences
Gordon McBean - Departments of Geography and Political Science, University of Western Ontario
Contact: aston@cfcas.org

The Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) is celebrating 10 years of excellent research. Its support has reinvigorated atmospheric, oceanic and climate science in Canada, fostered partnerships and helped train the next generation of climate and atmospheric scientists and oceanographers. CFCAS has funded more than 184 networks and projects – investing over $117 million in university-based research. Collaborations with scientists in other sectors have ensured that research results have been taken up and used, to the benefit of all Canadians. This session will highlight CFCAS's accomplishments, its influence on the scientific community and the impact of the funded work on operations, policy development and the well being of Canadians.

ARCTIC

The Arctic Environment in the 21st Century

James Drummond - Dalhousie University
Contact: james.drummond@dal.ca

The Arctic environment will undergo significant changes in the 21st century. The atmosphere, ocean, land and ecosystems will be under severe stress. Measurements and models of the Arctic environment will become increasingly important to our understanding of the region and decisions about its future. This session will bring together scientists from various disciplines of CMOS and CGU to share their experience and to discuss the present state of the Arctic and likely future trends.

Cryosphere-Climate Feedbacks

Paul Kushner - Department of Physics, University of Toronto
Richard Fernandes - Earth Sciences Sector, Natural Resources Canada
Contact: paul.kushner@utoronto.ca

Cryosphere-climate feedbacks involve cryospheric processes that amplify or dampen the response to radiative forcing arising from variations in atmospheric composition and insolation. Such feedbacks affect regional-scale and global climate sensitivity, as well as the direct cryospheric response --- in snow cover and sea ice extent, snow and sea ice melt/accumulation and in permafrost dynamics --- to this forcing. Contributions that highlight recent advances in our understanding of processes and strengths of cryosphere-climate feedbacks are solicited. These contributions can come from observational, modelling, or theoretical work, and can apply to past climates, recent climate, or projected future climates.

Storm Studies in the Arctic (STAR)

John Hanesiak - Centre for Earth Observation Science, University of Manitoba
Ronald Stewart
Contacts: fisico@cc.umanitoba.ca, ronald.e.stewart@gmail.com

Understanding extreme weather events in the Arctic is becoming more important as industry in the north increases and climate change in the region is rapid, and will have significant impact on weather patterns at high latitudes. The Storm Studies in the Arctic (STAR) program is a four-year research Network (2007-2010) focusing on extreme weather and its hazards in the southeast Arctic involving researchers from several universities and Environment Canada.

The network conducted a major meteorological field campaign between 10 October – 30 November 2007 and in February 2008, focused on southern Baffin Island, which is a region that experiences intense autumn and winter storms. In particular, data taken during the field campaign were focused on helping to document and better understand weather systems in the Arctic, as well as contributing to improved prediction, particularly of severe weather such as strong winds, significant precipitation and blowing snow. Attention was also given to topographic and air-sea effects on severe weather processes, as these are of marked importance to the Baffin Island region. As well, an important aspect of the STAR network initiative is engagement of the local community in two-way communication.

This session welcomes not only STAR submissions but rather all aspects of analyzing and improving prediction of weather at high latitudes, studies of severe weather at high latitudes, observations of weather, or model studies. Presentations on sharing knowledge with local communities are also invited.

Polar Climate Stability

Guido Vettoretti - University of Toronto
Shawn Marshall - University of Calgary
Markus Kienast - Dalhousie University
Contact: g.vettoretti@utoronto.ca

The high latitude amplification of climate change in response to greenhouse gas forcing is expected to impact the future stability of the polar cryosphere significantly. Polar climate stability spans a broad range of time-scales ranging from meteorological to geological time-scales and has evolved under natural and anthropogenic climate forcing. The presentations in this session will include but are not limited to the research generated within the Polar Climate Stability Network (PCSN). A great deal of our understanding about the climate system has been obtained through research in paleoclimatology and paleoceanography of the Quaternary. This session will be of interest to researchers that focus on ocean and climate dynamics of the past, and presentations on both warm and cold climate in recent geologic and in deep time epochs are encouraged. Presentations on the modern stability of the polar climate as well as those studying the current state of the polar climate and cryosphere are also of interest during this session. We welcome contributions from the analysis of geophysical data (marine and terrestrial) and from the modelling of the past, present and future states of continental glaciers and ice sheets to address the following issues:

- Polar Amplification of Climate Change
- Oxygen Isotopes as a Tracer of Climate Processes
- Mass Balance of the Polar Cryosphere
- Low-Latitude High-Latitude Teleconnections
- The Response of the Atlantic Thermohaline Circulation
- Past Epochs as an Analog for the Future
- Icehouse and Hothouse Dynamics

Operational sea-ice analysis and prediction

Mark Buehner, - Meteorological Research Division, Environment Canada
Tom Carrieres, - Canadian Ice Service, Environment Canada
Greg Flato, - Climate Research Division, Environment Canada
Roger De Abreu -Canadian Ice Service, Environment Canada
Contact: Mark.Buehner@ec.gc.ca

The changing Arctic climate, as demonstrated by record low ice coverage in recent years, is leading to increased marine transportation and natural resource development in and around ice covered waters. Appropriate use of accurate and timely sea ice analyses and forecasts, such as the operational products of the Canadian Ice Service (CIS), can result in significant economic and safety benefits for these activities. Accurate sea ice information can also lead to improved numerical weather prediction (NWP) for northern regions, especially when coupled ice-ocean-atmosphere forecast models are used. Recently, CIS and the Meteorological Research Division have been exploring the use of an objective analysis/prediction approach for tactical forecasts, similar to what is used for NWP. This approach relies on data assimilation techniques to combine information from available observational data (primarily from satellite-based instruments) and numerical models. For longer range forecasts, statistical modeling and ensemble techniques are being explored in projects such as the Canadian Long-range Ice Forecasting (CLIF) project. This session will focus on the components required for the successful development of such objective approaches, including 1) observations: all aspects of how remotely sensed and in situ data can provide useful information on sea ice concentration, thickness or type, etc. either by direct assimilation or the use of a retrieval algorithm; 2) forecast models: all aspects on the development of numerical and statistical sea-ice models and their application to sea-ice prediction over timescales of days to seasons and beyond; 3) data assimilation: all aspects of the development and application of techniques for the assimilation of sea-ice observations to produce objective estimates of sea-ice conditions and to provide initial conditions for forecast models.

IPY and Related Atmospheric, Oceanographic, and Hydrological Studies

Will Perrie - Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

The International Polar Year (IPY) 2007-2008 was a two year program of science, research & education focused on the polar regions. Canadian and international researchers from universities, northern communities, and governments are working to advance our understanding of cultural, social, economic and health dimensions, as well as geophysical, climate and biological processes. Submissions are encouraged from both IPY and non-IPY projects which will contribute to our understanding of atmospheric, oceanographic, and hydrological processes in the Arctic.

Systems modelling for better Arctic policy

Evan Davies - University of Alberta
Jennifer Lukovich - University of Manitoba
Contact: lukovich@cc.umanitoba.ca

System dynamics and other systems modeling techniques provide tools for linking science and policy development in the Canadian Arctic. A multidisciplinary approach, system dynamics offers insight into the complex causes of real-world events by identifying the manner in which nonlinear feedbacks within a system give rise to complex, and often counterintuitive, behaviours. Outcomes include identification of high-leverage policies, greater understanding of system structures and interconnections, and insight into the complex interactions between the subjects of multiple disciplines.

The challenges posed by climate change and globalization present an opportunity to northern communities to become models of sustainability and self-sufficiency. This session will therefore explore the future of the Canadian Arctic and its inhabitants through a systems modelling approach that represents feedbacks between changing physical (sea ice extent, coastal erosion, permafrost melt, surface air temperature, winds, amongst others) and socioeconomic (natural resource and renewable energy availability, population, energy consumption, transportation and infrastructure) conditions explicitly. Insights resulting from the work should aid in the development of policies that foster and promote sustainability and self-sufficiency in northern communities.

We invite contributions that focus on

connections between northern communities and renewable and alternative energy technology development, climate change science, water resources management, northern infrastructure, and traditional knowledge and the role of cultural continuity, with the aims of establishing beneficial policies that respect the tradition of northern communities, and identifying policy-making options within an evolving governance framework. Submissions from engineers, social and natural scientists, members of northern communities and their representatives, and policy-makers are welcome.

HYDROLOGY

Hydrology General Session

Sean Carey - Carleton University
Contact: sean_carey@carleton.ca

This session consist of contributions related to hydrology that do not fit appropriately into the other special sessions. In particular it will serve as a focus for general contributions to hydrology related to geophysical methods and remote sensing, stream flow prediction, and ground water and soil moisture variations.

Forest Hydrology and Water Management

Paul Egginton - NRCan
Contact: paul.egginton@nrcan-rncan.gc.ca

This session consists of contributions related to forest hydrology and forest water management.

Uncertainty in climate change impacts to the water cycle

Katrina Bennett, David Rodenhuis - Pacific Climate Impacts Consortium
Biljana Music, Daniel Caya - Ouranos - Consortium sur les changements climatiques
Contact: kbennett@uvic.ca

Accounting for uncertainty in climate change impacts to regional hydrological regimes is important for future management of water resources. Although major steps forward have been made in the development of global climate models, downscaling techniques and hydrologic modelling; methods and tools to quantitatively assess uncertainty that can be readily applied by decision makers are still scarce. How can managers make adequate decisions in the face of this uncertainty and how can the scientific community respond by providing them with applicable solutions for future planning? This session aims to present a cross-section of techniques for assessing uncertainty in climate change impacts on the hydrologic cycle. There will be a special focus on uncertainty quantification approaches that have been applied by water resource managers, decision-makers and planners and their outcomes.

Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction

John Pomeroy - University of Saskatchewan, Centre for Hydrology
Sean Carey - Carleton University, Dept. of Geography and Environmental Studies
Alain Pietroniro - Water Survey of Canada, Environment Canada
Bill Quinton - Wilfrid Laurier University, Cold Regions Research Centre
Diana Verseghy - Meteorological Service of Canada, Environment Canada
Contact: julie.friddell@usask.ca

Hydrological processes in cold regions include snow accumulation, redistribution, ablation and melt, soil freezing and thawing, subsurface water flow in partially frozen soil, and ice-related flow processes, evaporation, ice melt, runoff, and water redistribution. Advances in the numerical representation of snow and ice, open water, wet organic terrain, and permafrost in hydrological and land surface models are expected to improve hydrological, weather, and climate prediction in cold regions. Since cold regions processes dominate in runoff-generating headwaters, they have inordinately important effects on continental water resources and regional and global climate. This session aims to improve process understanding, parameterisation, and predictions in the sparsely gauged basins of Canada's cold regions as well as other alpine and polar regions. To this end, a broad range of topics relevant to the flux and storage of water in cold regions and/or cold seasons will be addressed. Detailed studies of processes are particularly welcomed, as are innovative modelling studies.

Classification, modeling, and inter-comparison studies of environmental controls on catchment hydrologic response

April James - North Carolina State University
Ilja Tromp-van Meerveld - Simon Fraser University
Contact: april_james@ncsu.edu

Inter-comparisons of catchment hydrological response are challenging due to variation in environmental conditions (e.g. antecedent moisture conditions, storm characteristics), environmental controls (e.g. climate, topography, soils, geology), and data limitations. Despite these challenges, they have proven to be useful. For instance, several hillslope and small catchment studies have identified threshold behavior in hydrologic response related to storm characteristics and antecedent moisture conditions and have identified fundamental environmental factors controlling runoff generation such as surface topography, subsurface topography and soil depth, soil cover type and distribution. In addition to inter-comparison studies there has been a recent increase in the number of modeling studies or virtual experiments to determine the controls on runoff generation. Despite these advances, the identification of where, when, under what conditions, and at what scale specific environmental factors are most important remains (largely) unanswered.

A recent series of papers attempts to address the challenges of inter-comparison studies by providing organizational frameworks with which to classify catchments and their behavior. This recent emphasis on catchment classification highlights the need for methodical testing of these frameworks with new and existing datasets and models as a way to identify critical environmental controls and to generalize their importance.

This session invites all studies on catchment classification, catchment inter-comparisons and catchment modeling that aim to identify which environmental controls are (most) important for runoff generation.

The Past, Present, and Future of glaciers in Western North America

Brian Menounos - University of Northern British Columbia
Dan Moore - University of British Columbia
Garry Clarke - University of British Columbia
Contact: menounos@unbc.ca

Mountain glaciers are a critical water resource, but they remain a poorly understood component of the hydrologic system. Glaciers can adjust their dimensions in response to changes in temperature and precipitation and so past fluctuations can often reveal the duration and magnitude of climatic events. In western Canada, glacier runoff is a vital component of surface flows to drainage basins of the eastern Rocky Mountains where runoff is used for agriculture, urban consumption, and industry. Hydroelectric power generation also relies on glacier runoff in glacierized basins of British Columbia. Finally, decline in glacier extent in western Canada and Alaska significantly contributes to sea level rise. The proposed session invites presentations on research that: i) reconstructs former glacier extents; ii) studies links between climate/meteorology and glacier nourishment ; iii) examines glacier mass balance or glacier hydrology or iv) models their past or future. We especially encourage papers that consider the implications of declining glacier cover and those that utilize a multi-disciplinary approach to investigate glacier change in the North American Cordillera.

GEODESY

Geodesy and Geodynamics

Joseph Henton - Geodetic Survey Division, Natural Resources Canada
Marcelo Santos - Dept of Geodesy and Geomatics Engineering - UNB
Contact: jhenton@nrcan.gc.ca

This session is open to papers within the broad depth of geodetic sciences and applications to geodynamics. This session encourages submission of papers dealing with the state-of-the-art in geodetic measurements involving ground and space techniques individually (e.g., GNSS, VLBI, gravity) or in combinations (towards GGOS), and interpretation and application of the geodetic signal into investigations towards Earth rotation and polar motion, precise orbit determination, analysis and prediction of processes involving the oceans, atmosphere and internal processes in the solid Earth.

On Advanced Geocomputations and Web Collaboration

Rod Blais, Mohamed Elhabiby - University of Calgary
Contacts: blais@ucalgary.ca, mmelhabi@ucalgary.ca

Geomatics and more generally geoscience is becoming more systems oriented with multi-disciplinary research related to Earth science. Among the computational challenges are the exponential increases in data volumes, diversity and complexity of datasets, data storage, access and preservation, multiresolution analysis and synthesis, semantic and syntactic data integration, advanced visualization, distributed computations and web collaboration. Contributions to any of these topics are invited for oral and/or poster presentation.

Geoid-based North American Vertical Datum

Marc Veronneau - Natural Resources Canada
Dan Roman - US National Geodetic Survey
Contact: marcv@nrcan.gc.ca

North America is moving towards a geoid-based vertical reference system. The implementation of such a vertical datum can occur as early as 2013 in Canada and later in the decade in the United States. Traditionally, vertical datums have been accessible through passive markers, which are expensive and time-consuming to maintain, as it requires levelling crew to walk literally across the country. Furthermore, these markers are mostly located along major roads and railways limiting them to southern Canada. Today's Global Navigation Satellite Systems technology (e.g. GPS) and current satellite gravity missions (GRACE and GOCE) provide the proper spatial infrastructure for accurate and efficient height and geoid determination, respectively. This will provide common and consistent heights above mean sea level anywhere across North America (land, lakes and oceans) allowing efficient water management among others. Furthermore, it will allow a link between terrestrial and oceanographic data.

The session welcomes topics related to the definition, realization and maintenance of the North American Vertical System. In addition, topics of interest include data collection and validation, improvements of geoid modelling theory, procedures in monitoring geoid changes and oceanographic datums.

BIOGEOSCIENCE

General Biogeoscience

Altaf Arain, - McMaster University
Elyn Humphreys - Carleton University
Contact: arainm@mcmaster.ca

This session will consist of contributions related to biogeoscience that do not fit appropriately into the other special sessions.

Interactions Among Biogeochemical Cycles

Carl Mitchell - University of Toronto - Scarborough
Rick Bourbonniere - Environment Canada
Merrin Macrae - University of Waterloo
Contact: carl.mitchell@utoronto.ca

Understanding the myriad of processes regulating biogeochemical cycles is critical to Canada's ability to properly regulate pollutant emission controls and to make sound land-use management decisions. Complexities within and among hydrologic and biogeochemical processes make definitive solutions difficult. The interactions and feedbacks between disparate biogeochemical cycles, particularly at interfaces between ecosystems, only compound this difficulty. This is especially the case when measures to reduce the deleterious effects of one process result in the production and/or accumulation of another harmful substance. Papers for this session should focus on the interaction of different biogeochemical cycles from micro- to global scales. Broad disciplinary perspectives from the biogeosciences, hydrology, ecology, and geology are welcome and papers presenting original field, laboratory, and/or modeling data will be considered. Examples are the interaction between sulphur and carbon cycles, such as methanogenesis suppression via stimulation of sulphate reduction, or the cycling and transport of nutrients from agriculture impacting natural riparian and stream biogeochemistry, but papers on a variety of interacting biogeochemical cycles or cycling at interfaces are welcome. As is indicated in the theme of the meeting, biogeoscience studies with forward-looking perspectives and/or ideas on linking results to policy are especially encouraged.

Carbon Cycling of Canadian Forests and Peatlands

Hank Margolis - Université Laval
Harry McCaughey - Queen's University
Contact: Hank.Margolis@sbf.ulaval.ca

This session will showcase some of the impacts and findings of the Fluxnet-Canada Research Network (FCRN) and the Canadian Carbon Program (CCP). These networks brought together researchers from universities and from provincial and federal agencies to address the role of forests and peatlands in the carbon cycle of Canada and integrate these results with research initiatives at continental and global scales. Over 100 graduate students and postdocs have been trained. FCRN ran from 2002 to 2007 and was the first national network to measure systematically the carbon, water and energy fluxes from Canada's managed forests and wetlands on a continuous basis. The fluxes of carbon dioxide, heat, water, and momentum were measured by eddy covariance on towers from British Columbia to New Brunswick at selected sites. A suite of backbone meteorological and site-level ecological data was also measured. These data have been used to develop and test models of site-level and regional ecosystem carbon balance. The CCP (2007-2010) built upon the foundation of the FCRN and expanded the program to include “tall tower” measurements and atmospheric inversion modelling of regional carbon balance. Impacts of several types of forest disturbance will be highlighted, including the changing carbon sequestration rates following logging and fires. Also, data will be presented on the changing carbon sequestration in chronosequences of jack pine (Saskatchewan), black spruce (Quebec), white pine plantation (Ontario), and Douglas fir (British Columbia). The significance of the work to public policy formulation will be discussed.

SOLID EARTH

Crust to Core: Structure observations & models

Catrina Alexandrakis - University of Calgary
Jeff Gu - University of Alberta
Contact: alexanc@ucalgary.ca

The availability of broadband instruments has substantially increased our ability to resolve and characterize seismic structures. It motivates theoretical advances and facilitates novel applications pertaining to the Earth’s mantle and core. This session aims to highlight recent results and methodologies that take advantage of improved global/ regional data coverage to achieve a better overall understanding of the lithosphere dynamics, mantle convection and core-mantle interactions. We emphasize the diverse aspects of, and improved solutions to, the ‘global’ problem. We welcome contributions targeting a broad range of depths, spatial scales and geographical locations.

Mantle Processes and Structure

Julian Lowman - University of Toronto
Gary Jarvis - York University
Contact: lowman@utsc.utoronto.ca

Processes occurring in the mantle control the means by which heat is removed from the mantle and core of a rocky planet like the Earth. They include the driving forces responsible for plate tectonics, volcanism, earthquakes and orogenesis. Mantle processes also influence a planet's topography and gravitational field, and in the case of the Earth, the geodynamo and the formation of mineral and hydrocarbon resources. Vital to improving our understanding of terrestrial mantle dynamics is improved knowledge of the mineralogical, chemical and thermal structure of the Earth's mantle, particularly the regions encompassed by the thermal boundary layers. This session encourages submissions from a broad range of subjects related to the Earth's mantle and Planetary mantles in general, particularly contributions from seismology, high pressure mineral physics, geodynamics and tectonophysics.

Polarimetric SAR(Synthetic Aperture Radar) Applications in Geophysics of Solid Earth and Ocean : (RADARSAT-2 Special Session)

Wooil Moon - The University of Manitoba
Contact: wmoon@cc.umanitoba.ca

With recent launching of several new fully polarimetric SAR systems on-board satellites such as ALOS (Advanced Land Observation Satellite)(JAXA< Japan), TerraSAR-X (DLR, Germany), RADARSAT-2 (MDA/CSA, Canada), it is not only timely but also new application developments are urgently needed for geophysics. I propose to organize a Special Session with focus on the fully polarimetric SAR applications in Geophysics. If possible, I would also invite a couple of international leaders/researchers in this field, in addition to the papers from Canadian scientists and engineers.

Seismic Microzonation

Dariush Motazedian - Carleton University
Jim Hunter - Geological Survey of Canada, Ottawa
Contact: Dariush_Motazedian@Carleton.ca

Seismic microzonation aims to improve seismic hazard estimates by including detailed information on earthquake site response across a city or region. This is an important component in the development of more realistic ground motion predictions for seismic hazard analyses, because the level of seismic ground shaking is strongly influenced by site conditions. Site effects are parameterized on the basis of geophysical and geotechnical soil properties. One example is Vs30 (shear-wave velocity in upper 30 m), currently in use in many building codes as an index by which to scale site amplification effects. This parameter provides a quantitative measure that address some, but not all, of the aspects seismic soil behaviour, with other factors such as soil depth or fundamental period being also very important. Ground motion predictions may be improved either by “generic” adjustments using site amplification factors, or by undertaking more detailed site-specific geotechnical analyses of local site response effects. We invite papers that address any aspect of seismic microzonation studies, but in particular encourage those that may offer some improvements to currently-used techniques for characterizing site effects.

The Laboratory Prospect to the Earth: Advances in Mineral and Rock Physics

Hans J. Mueller - GFZ German Research Centre for Geoschiences
Rick Secco - University of Western Ontario
Contact: hjmuel@gfz-potsdam.de

The progress in geophysical studies of the Earth`s interior requires more and more the fundamental understanding of physical and chemical processes inside the Earth as well as exact knowledge of the relation between the material / structural properties and the physical properties of rocks and minerals under in situ conditions. Based on developments of digital measuring techniques and improved materials the progress in mineral and rock physics during the last decade was dramatic. Last not least these developments were accompanied and accelerated by the fast growing abilities of numerical simulations for handling even complicate geological structures and processes. Realistic digital models require reliable and precise in situ data to meet the requirements for the interpretation of recent geophysics, geodynamics and geology. This interdisciplinary session aims to intensify the discussion between geophysicists and geologists, mineral and rock physicists and numerical modelists. We encourage scientists of all those disciplines to contribute their results and ideas, to participate and to benefit from this intensified information exchange.

Recent developments in airborne geophysics

Claire Samson - Dept. of Earth Sciences, Carleton University
Luise Sander - Sander Geophysics Ltd.
Contact: claire_samson@carleton.ca

Airborne geophysics is a rapidly-evolving, innovative and competitive field that responds to market demands for added value. This is particularly true in the current economic climate.

This session features recent developments in platforms, sensors and analysis methods for airborne gravity, magnetics, electromagnetics, radiometrics and laser imaging. Of particular interest are new platforms, for example, low-altitude heliported systems and unmanned air vehicles that have the potential of revolutionizing exploration in rough topography. Another area of growing interest is the fusion of data captured by different geophysical sensors, leading to enhanced visual products and maps. Airborne Lidar, for example, has become a valuable technology that allows building digital elevation models that can be combined with classical potential field data. This integrated approach contributes to more accurate target detection and delineation. With the increased data volume, new analysis strategies are being designed to deliver results quickly and efficiently, in many cases, in real- or near real-time.

The session welcomes contributions focusing on technology advances and case histories for applications ranging from natural resource exploration to mapping unchartered terrains. In line with the conference's general theme, contributions related to environmental monitoring are particularly encouraged. The session also aims at bringing together geophysicists and engineers engaged in research and development in airborne geophysics, and working in academia, the public section and private industry.

Geophysics in sensitive environmental sites

Claire Samson - Dept. of Earth Sciences, Carleton University
Erwan Gloaguen - INRS, Centre Eau, Terre & Environnment, Quebec, QC
Contact: claire_samson@carleton.ca

In line with the conference's general theme "Our Earth, Our Air, Our Water: Our Future", this session focuses on current geophysical studies in sensitive environmental sites. Sensitive sites includes delicate natural environments, for example, wildlife corridors and marshlands, were geophysical surveys must be conducted in a non-destructive way. Sensitive sites also consist of problematic sites, like mine tailings impoundments and landfills, whose impact on the environment requires monitoring through long periods of time.

The session welcomes contributions focusing on technology advances, best practices and case histories for a wide range of applications spanning the complete process from site selection, design, operation, and decommissioning. Examples include, but are not restricted to: the use of near-surface geophysics to delineate and track contaminant plumes; geophysical logging of monitoring wells; geophysical surveys in support of environmental site assessments (ESA); and geophysical methods for evaluating the stability of tailings impoundments and for monitoring acid mine drainage. Examples from all geophysical methods – gravity, electrical and electromagnetic methods, ground penetrating radar (GPR), radiometrics, etc. – are sought.

The session aims at bringing together geophysicists and representatives from other key disciplines involved in environmental monitoring and remediation such as environmental, civil and mining engineers, hydrogeologists and hydrologists, and biogeoscientists.

Insights into seismic hazard

Kristy Tiampo, Robert Shcherbakov - University of Western Ontario
Contact: ktiampo@uwo.ca

In recent years, advances in theoretical analysis, laboratory experiments, field observations, and computer simulations have led to significant progress toward the long term goal of understanding the nature of seismic sources and the construction of a quantitative physical model for the entire earthquake process. However, much work remains in order to appropriately link these new insights to improved estimates of seismic risk and hazard. Here we solicit submissions that contribute to our understanding of the physics of the earthquake process. Of particular interest are studies of the emerging systematic methods which increase our knowledge of the physical processes responsible for the distribution of earthquakes in space and time, and new models, technologies, and tools which quantify both the seismotectonic process and its evolution, and the accompanying seismic hazard estimates for various tectonic regions. Particular emphasis will be placed on (1) earthquake nucleation and dynamic rupture processes; (2) comprehensive physical modeling; (3) space-time patterns of seismicity and related geophysical fields; and (4) seismic hazard estimation.

Canadian Geophysical Union
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Geophysical Sciences for the Future

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Biogeosciences…………………………………Biogéosciences

Solid Earth……………………Physique des systèmes terrestres

WORKSHOP PROPOSALS / PROPOSITIONS POUR ATELIERS

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Field Trip / Excursion: Columbia Icefield, May 15 Mai, 2011

For more information, contact: Rod Blais, University of Calgary, blais@ucalgary.ca


Canadian Meteorological and Oceanographic Society
La Société canadienne de météorologie et d'océanographie
45th CMOS Congress
45e Congrès de la SCMO
Ocean, Atmosphere and the Changing Pacific
Océan, Atmosphère et le Pacifique en Transition
Victoria 2011
British Columbia / Colombie-Britannique, Canada
June 5 - 9 / 5 - 9 juin
http://www.cmos.ca/congress2011
Race Rocks Lighthouse: Photo courtesy of SpringTideCharters

Week at a glance

Monday, 31 May 2010

	Ballroom A (Room ID 1)	Ballroom B (Room ID 2)	Ballroom C (Room ID 3)	Richelieu (Room ID 4)	Frontenac (Room ID 5)	Joliet (Room ID 6)	Chaudière (Room ID 7)	Capitale (Room ID 8)	Panorama (Room ID 9)	Pinnacle (Room ID 10)	Bytowne (Room ID 11)	York (Room ID 12)	Laurentian (Room ID 13)	Place de Ville Conf Rm 1 (Room ID 14)
08:00 12:00				CNC SCOR AGM 9:00-1:00	CMOS Private Sector Committee	CGU Hydrology	CGU Solid Earth				CGU Geodesy	CMOS Publications Committee	CGU Bio-geosciences	
13:00 14:30			GOAPP Workshop		DRI	CMOS Scientific Committee	CMOS Univ & Prof Educ Comm	GGOS Workshop				CMOS Centre Chairs Committee		
14:30 17:00				CMOS Council 2:30-4:00	IP3 (3:00-5:00)									
17:00 18:00				CFCAS AGM 4:00-6:00	IP3-DRI-WC2N Reception									
18:00 22:00									Icebreaker Reception					

Tuesday, 1 June 2010

		Ballroom A (Room ID 1)	Ballroom B (Room ID 2)	Ballroom C (Room ID 3)	Richelieu (Room ID 4)	Frontenac (Room ID 5)	Joliet (Room ID 6)	Chaudière (Room ID 7)	Capitale (Room ID 8)	Panorama (Room ID 9)	Pinnacle (Room ID 10)	Bytowne (Room ID 11)	York (Room ID 12)	Laurentian (Room ID 13)	Place de Ville Conf Rm 1 (Room ID 14)
	08:30 09:00	Opening Ceremonies													
1A	09:00 10:30	Opening Session, Plenary 1A													
	10:30 11:00	HEALTH BREAK													
1B	11:00 12:30	Lawrence Mysak Session on Ocean and Climate Dynamics (Part 1)		Uncertainty in climate change impacts to the water cycle (Part 1)	Coupled Atmosphere-Ocean Prediction and Predictability (Part 1)	Interactions Among Bio-geochemical Cycles (Part 1)	Climate change and the carbon cycle (Part 1)	Stratospheric Processes and their Role in Climate (Part 1)	Recent developments in airborne geophysics (Part 1)	Ocean Climate Change, Variability and Impacts (Part 1)	Oceanography General Session		Mantle Processes and Structure	Geoid-based North American Vertical Datum	Drought, Climate and Society (Part 1)
	12:30 14:00		MYSAK LUNCHEON	LUNCH											
1C	14:00 15:30	Interactions Among Bio-geochemical Cycles (Part 2)		Lawrence Mysak Session on Ocean and Climate Dynamics (Part 2)	Uncertainty in climate change impacts to the water cycle (Part 2)	The Arctic Environment in the 21st Century	Ocean Climate Change, Variability and Impacts (Part 2)	Coupled Atmosphere-Ocean Prediction and Predictability (Part 2)	Stratospheric Processes and their Role in Climate (Part 2)	Drought, Climate and Society (Part 2)	Climate change and the carbon cycle (Part 2)	Ocean Observatories: Online and Operational		On Advanced Geo-computations and Web Collaboration	Recent developments in airborne geophysics (Part 2)
	15:30 16:00	HEALTH BREAK													
1P	16:00 18:00	Poster Session and Reception on Terrace													
	18:00 19:00					CGU AGM		CSAFM AGM							
	19:00 21:00				CMOS AGM										

Wednesday, 2 June 2010

			Ballroom A (Room ID 1)	Ballroom B (Room ID 2)	Ballroom C (Room ID 3)	Richelieu (Room ID 4)	Frontenac (Room ID 5)	Joliet (Room ID 6)	Chaudière (Room ID 7)	Capitale (Room ID 8)	Panorama (Room ID 9)	Pinnacle (Room ID 10)	Bytowne (Room ID 11)	York (Room ID 12)	Laurentian (Room ID 13)	Place de Ville Conf Rm 1 (Room ID 14)
2A	08:30	10:00		Plenary Day 2												
	10:00	10:30	HEALTH BREAK													
2B	10:30	12:00				Lawrence Mysak Session on Ocean and Climate Dynamics (Part 3)	Stratospheric Processes and their Role in Climate (Part 3)	Coupled Atmosphere-Ocean Prediction and Predictability (Part 3)	Operational Oceanography: observations, modelling and data assimilation (Part 1)	Interactions Among Bio-geochemical Cycles (Part 3)	Weather and Society - Integrated Studies (Part 1)	General Hydrology Session (Part 1)	Aviation Meteorology	Insights into seismic hazard	Geodesy and Geodynamics	CFCAS Achievements - The First Decade
	12:00	14:00		PATTERSON-PARSONS LUNCHEON						CGU BBQ (on the Terrace)						
2C	14:00	15:30				Atmosphere, Ocean, and Climate Dynamics (Part 1)	Operational Oceanography: observations, modelling and data assimilation (Part 2)	General Hydrology Session (Part 2)	The upper troposphere and lower stratosphere (UTLS) (Part 1)	Weather and Society - Integrated Studies (Part 2)	General Atmospheric Sciences (Part 1)	Low-frequency variability and predictability (Part 1)	Remote Sensing of the Oceans	Crust to Core: Structure observations & models (Part 1)	GEOID Workshop	Stratospheric Processes and their Role in Climate (Part 4)
	15:30	16:00	HEALTH BREAK													
2D	16:00	17:30	Atmosphere, Ocean, and Climate Dynamics (Part 2)	General Hydrology Session (Part 3)	Weather and Society - Integrated Studies (Part 3)	General Atmospheric Sciences (Part 2)	Geophysics in sensitive environmental sites (Part 1)	Classification, modelling, and inter-comparison studies of environmental controls on catchment hydrologic response	Climate Change and Extreme Events (Part 1)	Low-frequency variability and predictability (Part 2)	The upper troposphere and lower stratosphere (UTLS) (Part 2)	Seismic Microzonation		Physical-Biological Interactions in the Aquatic Environments	GEOID Workshop	August 20th 2009 Ontario Tornado Outbreak
	18:00	19:00					NSERC TOWNHALL									
	19:00	20:00		CMOS-CGU RECEPTION												
	20:00	21:30		PUBLIC LECTURE												

Thursday, 3 June 2010																
			Ballroom A (Room ID 1)	**Ballroom B (Room ID 2)**	**Ballroom C (Room ID 3)**	**Richelieu (Room ID 4)**	**Frontenac (Room ID 5)**	**Joliet (Room ID 6)**	**Chaudière (Room ID 7)**	**Capitale (Room ID 8)**	**Panorama (Room ID 9)**	**Pinnacle (Room ID 10)**	**Bytowne (Room ID 11)**	**York (Room ID 12)**	**Laurentian (Room ID 13)**	**Place de Ville Conf Rm 1 (Room ID 14)**
3A	**08:30**	**10:00**		Plenary Day 3							Teachers' Day A					
	10:00	**10:30**	HEALTH BREAK													
3B	**10:30**	**12:00**	Regional Climate Modelling (Part 1)	When the atmosphere and the ocean get along over the Gulf of St. Lawrence (Part 1)	General Atmospheric Sciences (Part 3)	Forest Hydrology and Water Management	Micrometeorology of Canadian Ecosystems	The upper troposphere and lower stratosphere (UTLS) (Part 3)	Low-frequency variability and predictability (Part 3)	The Past, Present, and Future of glaciers in Western North America (Part 1)	Teachers' Day B	Atmosphere, Ocean, and Climate Dynamics (Part 3)	Our Roads - Road Weather Service Developments	Ocean Biogeochemistry Responses to Environmental Change		Geophysics in sensitive environmental sites (Part 2)
	12:00	**13:30**	LUNCH													
3C	**13:30**	**15:00**	Atmosphere, Ocean, and Climate Dynamics (Part 4)	Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 1)	Regional Climate Modelling (Part 2)	Cloud-Aerosol Interactions (Part 1)	Weather and Climate Monitoring in Canada - Current operations and future directions (Part 1)	Low-frequency variability and predictability (Part 4)	When the atmosphere and the ocean get along over the Gulf of St. Lawrence (Part 2)	Polar Climate Stability (Part 1)	Teachers' Day C	The Past, Present, and Future of glaciers in Western North America (Part 2)	Acoustics in Oceanography	Health Issues of Weather and Climate		Climate Change and Extreme Events (Part 2)
	15:00	**15:30**	HEALTH BREAK													
3D	**15:30**	**17:30**	Poster Session and Reception on Terrace							Poster Session and Reception on Terrace	Teachers' Day D	Poster Session and Reception on Terrace				
	17:30															
	18:00	**19:00**							ARGO TOWNHALL	Media Science						
	19:00	**21:30**	CMOS BANQUET			CGU BANQUET										

Friday, 4 June 2010

			Ballroom A (Room ID 1)	Ballroom B (Room ID 2)	Ballroom C (Room ID 3)	Richelieu (Room ID 4)	Frontenac (Room ID 5)	Joliet (Room ID 6)	Chaudière (Room ID 7)	Capitale (Room ID 8)	Panorama (Room ID 9)	Pinnacle (Room ID 10)	Bytowne (Room ID 11)	York (Room ID 12)	Laurentian (Room ID 13)	Place de Ville Conf Rm 1 (Room ID 14)
4A	08:30	10:00		Plenary Day 4												
	10:00	10:30	HEALTH BREAK													
4B	10:30	12:00	Coastal Oceanography and Inland Waters (Part 1)	Ensemble forecasting: current and emerging applications (Part 1)	Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 2)	IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 1)	Cloud-Aerosol Interactions (Part 2)	Weather and Climate Monitoring in Canada - Current operations and future directions (Part 2)	Operational sea-ice analysis and prediction (Part 1)	Polar Climate Stability (Part 2)	Regional Climate Modelling (Part 3)	Carbon Cycling of Canadian Forests and Peatlands (Part 1)	The Laboratory Prospect to the Earth: Advances in Mineral and Rock Physics			Water, weather, and climate serving the energy sector
	12:00	13:30	LUNCH													
4C	13:30	15:00	Weather and Climate Monitoring in Canada - Current operations and future directions (Part 3)	IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 2)	Ensemble forecasting: current and emerging applications (Part 2)	Coastal Oceanography and Inland Waters (Part 2)	Operational sea-ice analysis and prediction (Part 2)	Regional Climate Modelling (Part 4)	Storm Studies in the Arctic (STAR) (Part 1)	Carbon Cycling of Canadian Forests and Peatlands (Part 2)	Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 3)	Air Quality and Atmospheric Chemistry from Space to the Boundary Layer (Part 1)	Systems modelling for better Arctic policy	Crust to Core: Structure observations & models (Part 2)		Wind Energy
	15:00	15:30	HEALTH BREAK													
4D	15:30	17:00	IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 3)	Regional Climate Modelling (Part 5)	Weather and Climate Monitoring in Canada - Current operations and future directions (Part 4)	Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 4)	Cryosphere-Climate Feedbacks	Storm Studies in the Arctic (STAR) (Part 2)	Air Quality and Atmospheric Chemistry from Space to the Boundary Layer (Part 2)	Environmental Prediction in Canadian Cities	Coastal Oceanography and Inland Waters (Part 3)	Operational sea-ice analysis and prediction (Part 3)				The Vancouver 2010 Olympic and Paralympic Games

Aperçu de la semaine

Lundi, 31 mai 2010

		Salle de bal A (Pièce #1)	Salle de bal B (Pièce #2)	Salle de bal C (Pièce #3)	Richelieu (Pièce #4)	Frontenac (Pièce #5)	Joliet (Pièce #6)	Chaudière (Pièce #7)	Capitale (Pièce #8)	Panorama Pièce #9)	Pinnacle (Pièce #10)	Bytowne (Pièce #11)	York (Pièce #12)	Laurentian (Pièce #13)	Place de Ville Conf Rm 1 (Pièce #14)
08:00	12:00				CNC SCOR 09h00-13h00	Comité du secteur privé SCMO	Hydrologie UGC	UGC Terre solide				UGC Géodésie	Comité des publications SCMO	Biogéosciences UGC	
13:00	14:30			Atelier GOAPP		Atelier DRI	Comité scientifique SCMO	Comité SCMO sur l'éducation universitaire et professionnelle	Atelier GGOS				Comité des présidents de centres SCMO		
14:30	17:00				Conseil SCMO 14h30-16h00	IP3 15h00-17h00									
17:00	18:00				AGA FCSA 16h00-18h00	Réception IP3 - DRI - WC2N									
18:00	22:00									RÉCEPTION BRISE GLACE					

Mardi, 1 juin 2010

			Salle de bal A (Pièce #1)	Salle de bal B (Pièce #2)	Salle de bal C (Pièce #3)	Richelieu (Pièce #4)	Frontenac (Pièce #5)	Joliet (Pièce #6)	Chaudière (Pièce #7)	Capitale (Pièce #8)	Panorama (Pièce #9)	Pinnacle (Pièce #10)	Bytowne (Pièce #11)	York (Pièce #12)	Laurentian (Pièce #13)	Place de Ville Conf Rm 1 (Pièce #14)
	08:30	09:00	Cérémonies d'ouverture													
1A	09:00	10:30	Session d'ouverture, plénière 1A													
	10:30	11:00	PAUSE SANTÉ													
1B	11:00	12:30	Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 1)		Incertitude quant aux effets du changement climatique sur le cycle de l'eau (Partie 1)	Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 1)	Interactions entre les cycles bio-géochimiques (Partie 1)	Le cycle du carbone et les changements climatiques (Partie 1)	Les processus stratosphériques et leur incidence sur le climat (Partie 1)	Nouveautés en géophysique aérienne (Partie 1)	Changements et variabilité du climat océanique et leurs effets (Partie 1)	Séance générale sur l'océanographie		Processus et structure du manteau	Référentiel altimétrique nord-américain fondé sur le géoïde	Sécheresse, climat et société (Partie 1)
	12:30	14:00		Dîner MYSAK	Dîner											
1C	14:00	15:30	Interactions entre les cycles bio-géochimiques (Partie 2)		Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 2)	Incertitude quant aux effets du changement climatique sur le cycle de l'eau (Partie 2)	L'environnement arctique au 21e siècle	Changements et variabilité du climat océanique et leurs effets (Partie 2)	Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 2)	Les processus strato-sphériques et leur incidence sur le climat (Partie 2)	Sécheresse, climat et société (Partie 2)	Le cycle du carbone et les changements climatiques (Partie 2)	Observatoires océaniques : en ligne et opérationnels		Calcul informatisé avancé en géomatique et collaboration Web	Nouveautés en géophysique aérienne (Partie 2)
	15:30	16:00	PAUSE SANTÉ													
1P	16:00	18:00	Session d'affiches et réception sur la Terrace													
	18:00	19:00					AGA UGC		AGA SCMAF							
	19:00	21:00				AGA SCMO										

Mercredi, 2 juin 2010

	Salle de bal A (Pièce #1)	Salle de bal B (Pièce #2)	Salle de bal C (Pièce #3)	Richelieu (Pièce #4)	Frontenac (Pièce #5)	Joliet (Pièce #6)	Chaudière (Pièce #7)	Capitale (Pièce #8)	Panorama (Pièce #9)	Pinnacle (Pièce #10)	Bytowne (Pièce #11)	York (Pièce #12)	Laurentian (Pièce #13)	Place de Ville Conf Rm 1 (Pièce #14)
2A 08:30 10:00		Plénière jour 2												
10:00 10:30	PAUSE SANTÉ													
2B 10:30 12:00				Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 3)	Les processus strato-sphériques et leur incidence sur le climat (Partie 3)	Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 3)	Océanographie opérationnelle : observations, modélisation et assimilation des données (Partie 1)	Interactions entre les cycles bio-géochimiques (Partie 3)	La météo et la société - Études intégrées (Partie 1)	Séance générale sur l'hydrologie (Partie 1)	Météorologie aéronautique	Risques sismiques	Géodésie et géodynamique	Réalisations de la FCSCA - La première décennie
12:00 14:00	DÎNER PATTERSON-PARSONS							BBQ de l'UGC (sur la Terrace)						
2C 14:00 15:30				Dynamiques de l'atmosphère, de l'océan et du climat (Partie 1)	Océanographie opérationnelle : observations, modélisation et assimilation des données (Partie 2)	Séance générale sur l'hydrologie (Partie 2)	Haute troposphère et basse stratosphère (HTBS) (Partie 1)	La météo et la société - Études intégrées (Partie 2)	Séance générale sur les sciences atmosphériques (Partie 1)	Variabilité et prévisibilité à basse fréquence (Partie 1)	Téléobservation des océans	De la croûte au noyau : observations de la structure et modèles (Partie 1)	Atelier GEOID	Les processus strato-sphériques et leur incidence sur le climat (Partie 4)
15:30 16:00	PAUSE SANTÉ													
2D 16:00 17:30	Dynamiques de l'atmosphère, de l'océan et du climat (Partie 2)	Séance générale sur l'hydrologie (Partie 3)	La météo et la société - Études intégrées (Partie 3)	Séance générale sur les sciences atmosphériques (Partie 2)	Géophysique dans les sites écolo-giquement vulnérables (Partie 1)	Classification, modélisation et études comparatives des mécanismes de contrôle environnementaux sur la réaction hydrologique des bassins versants	Le changement climatique et les évènements extrêmes (Partie 1)	Variabilité et prévisibilité à basse fréquence (Partie 2)	Haute troposphère et basse stratosphère (HTBS) (Partie 2)	Microzonage sismique		Interactions physiques et biologiques dans les environnements aquatiques	Atelier GEOID	Éruption de tornades du 20 août 2009 en Ontario
18:00 19:00					DISCUSSION CNRSG									
19:00 20:00	RÉCEPTION SCMO-UGC													
20:00 21:30	CONFÉRENCE PUBLIQUE													

Jeudi, 3 juin 2010

			Salle de bal A (Pièce #1)	Salle de bal B (Pièce #2)	Salle de bal C (Pièce #3)	Richelieu (Pièce #4)	Frontenac (Pièce #5)	Joliet (Pièce #6)	Chaudière (Pièce #7)	Capitale (Pièce #8)	Panorama (Pièce #9)	Pinnacle (Pièce #10)	Bytowne (Pièce #11)	York (Pièce #12)	Laurentian (Pièce #13)	Place de Ville Conf Rm 1 (Pièce #14)
3A	08:30	10:00	Plénière jour 3								Journée des enseignants A					
	10:00	10:30	PAUSE SANTÉ													
3B	10:30	12:00	Modélisation régionale du climat (Partie 1)	Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent (Partie 1)	Séance générale sur les sciences atmosphériques (Partie 3)	Hydrologie forestière and gestion des eaux	Micro-météorologie des écosystèmes canadiens	Haute troposphère et basse stratosphère (HTBS) (Partie 3)	Variabilité et prévisibilité à basse fréquence (Partie 3)	Glaciers de l'ouest de l'Amérique du Nord : passé, présent et futur (Partie 1)	Journée des enseignants B	Dynamiques de l'atmosphère, de l'océan et du climat (Partie 3)	Nos routes - Le point sur la météorologie routière	Réactions biogéo-chimiques de l'océan aux changements environnementaux		Géophysique dans les sites écologiquement vulnérables (Partie 2)
	12:00	13:30	DÎNER													
3C	13:30	15:00	Dynamiques de l'atmosphère, de l'océan et du climat (Partie 4)	Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 1)	Modélisation régionale du climat (Partie 2)	Interactions nuages-aérosols (Partie 1)	Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 1)	Variabilité et prévisibilité à basse fréquence (Partie 4)	Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent (Partie 2)	Stabilité du climat polaire (Partie 1)	Journée des enseignants C	Glaciers de l'ouest de l'Amérique du Nord : passé, présent et futur (Partie 2)	L'Acoustique dans l'Océanographie	Conditions météorologiques et climat : effets sur la santé		Le changement climatique et les évènements extrêmes (Partie 2)
	15:00	15:30	PAUSE SANTÉ													
3D	15:30	17:30	Session d'affiches et réception sur la Terrace							Session d'affiches et réception sur la Terrace	Journée des enseignants D	Session d'affiches et réception sur la Terrace				
	17:30								DISCUSSION ARGO	Science pour les médias						
	18:00	19:00														
	19:00	21:30	BANQUET SCMO			BANQUET UGC										

Vendredi, 4 juin 2010

			Salle de bal A (Pièce #1)	Salle de bal B (Pièce #2)	Salle de bal C (Pièce #3)	Richelieu (Pièce #4)	Frontenac (Pièce #5)	Joliet (Pièce #6)	Chaudière (Pièce #7)	Capitale (Pièce #8)	Panorama (Pièce #9)	Pinnacle (Pièce #10)	Bytowne (Pièce #11)	York (Pièce #12)	Laurentian (Pièce #13)	Place de Ville Conf Rm 1 (Pièce #14)
4A	08:30	10:00		Plénière jour 4												
	10:00	10:30	PAUSE SANTÉ													
4B	10:30	12:00	Océanographie côtière et les eaux intérieures (Partie 1)	Prévisions d'ensemble : applications actuelles et émergentes (Partie 1)	Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 2)	AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie (Partie 1)	Interactions nuages-aérosols (Partie 2)	Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 2)	Analyse opérationnelle et prévision des glaces de mer (Partie 1)	Stabilité du climat polaire (Partie 2)	Modélisation régionale du climat (Partie 3)	Cycle du carbone des forêts et tourbières canadiennes (Partie 1)	Exploration des profondeurs de la Terre : progrès en physique des minéraux et des roches réalisés grâce aux laboratoires			L'eau, la météo et le climat au service du secteur énergie
	12:00	13:30	DÎNER													
4C	13:30	15:00	Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 3)	AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie (Partie 2)	Prévisions d'ensemble : applications actuelles et émergentes (Partie 2)	Océanographie côtière et les eaux intérieures (Partie 2)	Analyse opérationnelle et prévision des glaces de mer (Partie 2)	Modélisation régionale du climat (Partie 4)	Programme Storm Studies in the Arctic (STAR) (Partie 1)	Cycle du carbone des forêts et tourbières canadiennes (Partie 2)	Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 3)	Qualité de l'air et chimie de l'atmosphère de l'espace à la couche limite (Partie 1)	Modélisation de système pour une meilleure politique arctique	De la croûte au noyau : observations de la structure et modèles (Partie 2)		Énergie éolienne
	15:00	15:30	PAUSE SANTÉ													
4D	15:30	17:00	AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie (Partie 3)	Modélisation régionale du climat (Partie 5)	Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 4)	Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 4)	Cryosphère : rétroaction cryosphère-climat	Programme Storm Studies in the Arctic (STAR) (Partie 2)	Qualité de l'air et chimie de l'atmosphère de l'espace à la couche limite (Partie 2)	Prévisions environnementales pour les villes canadiennes	Océanographie côtière et les eaux intérieures (Partie 3)	Analyse opérationnelle et prévision des glaces de mer (Partie 3)				Les Jeux olympiques et paralympiques d'hiver de Vancouver 2010

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Dans l’index situé à la fin de quelques documents, le nom des auteurs est suivi des numéros d’identification et de présentation de tous les résumés correspondants.

Plenary Day 1 / Plénière jour 1

Room / Endroit (Ballrooms ABC), Chair / Président (Bill Crawford and Spiros Pagiatakis), Date (01/06/2010), Time / Heure (08:30 - 10:30)

P1.1 ID:4106 INVITED/INVITÉ 08:30

Global Geodetic Observing System and satellite gravimetry contributions to Earth monitoring

Michael Sideris
University of Calgary
Contact: sideris@ucalgary.ca

The Global Geodetic Observing System (GGOS) has been established by the International Association of Geodesy (IAG) in order to monitor fundamental geodetic parameters, and their temporal variations, with a relative accuracy of 10-9 or better. These geodetic parameters deal with the determination and evolution of the Earth's (i) geometry (topography, bathymetry, ice surface, sea level), (ii) rotation and orientation (polar motion, rotation rate, nutation, etc.), and (iii) gravity field (gravity, geoid, density distribution). Therefore, Earth observation on a global scale is at the heart of GGOS's activities, which contributes to global change research through the monitoring, as well as the modeling, of dynamic Earth processes such as mass and angular momentum exchanges, mass transport and ocean circulation, changes in sea, land and ice surfaces, and geohazards. GGOS relies on an integrated network of terrestrial, airborne and satellite systems and technologies, which include: various positioning, navigation, remote sensing and dedicated gravity and altimetry satellite missions; global ground networks of VLBI, SLR, DORIS, GNSS and absolute and relative gravity stations; and airborne gravity, mapping and remote sensing systems. This presentation will introduce GGOS and its applications in Earth monitoring in general, and will highlight its satellite segment and in particular the dedicated gravity satellite missions of CHAMP, GRACE and GOCE. These missions provide detailed information on the Earth's gravity field and its changes in time with a monthly resolution. The gravity field variations observed by GRACE have greatly enhanced our understanding of mass transport in the system Earth (global/regional hydrology, glaciology, oceanography, geodynamics). GOCE will provide gravity gradient data, which will improve global and regional models of the Earth's gravity field and geoid (1 mGal and 1 cm accuracy, respectively, at 100 km spatial resolution). The presentation will conclude with a discussion of the plans for a geoid-based global height reference system.

P1.2 ID:3399 INVITED/INVITÉ 09:15

A World of Change: Climate Yesterday, Today and Tomorrow

Susan Solomon
NOAA
Contact: susan.solomon@noaa.gov

Evidence that the Earth's climate system is warming is unequivocal. Understanding how temperatures are increasing around the world, how ice is melting at the poles, and how rain is decreasing in key regions are among the critical issues attracting the attention of scientists and policymakers worldwide. Recent work has shown that man-made warming that takes place due to increases in carbon dioxide concentration is nearly irreversible for more than 1000 years after emissions stop. This is due to physical linkages between transport of heat and of carbon dioxide to the deep ocean, rendering the cumulative effects of every year's carbon dioxide emissions and resulting climate changes unique among major anthropogenic greenhouse gases. Mechanisms responsible for this behavior will be discussed, and the relationship to other greenhouse gases will also be described. It will be shown that unabated increases of carbon dioxide in the coming century could cause dry-season rainfall reductions in several regions comparable to those of the 'dust bowl' era, as well as slow but inexorable sea level.

Lawrence Mysak Session on Ocean and Climate Dynamics (Part 1) / Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 1)

Room / Endroit (Ballroom A), Chair / Président (W. Hsieh), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B01.1 ID:3374 INVITED/INVITÉ 11:00

Geostrophic adjustment problems in a prototype Arctic basin

Andrew Willmott , *Maria Luneva* , *Miguel Maqueda*
Proudman Oceanographic Laboratory
Contact: ajwil@pol.ac.uk

During the first twenty years, or so, of Lawrence’s research career he, and his team of graduate students, postdoctoral researchers and sabbatical visitors, significantly advanced the knowledge base on topographic Rossby wave generation and propagation in the oceans. The “UBC Years” as I will refer to this period of Lawrence’s career saw him emerge as one of the foremost experts on low-frequency topographic Rossby waves trapped over continental shelves (usually referred to as “coastal trapped waves”).

In my presentation topographic Rossby waves and coastally trapped Kelvin waves play a starring role. I will discuss a series of geostrophic adjustment problems in a prototype Arctic basin. The basin is circular and supports a variety of idealised topographic features. For all the problems discussed the ocean is assumed to be homogeneous. Two classes of adjustment problems are examined; (i) a uniformly rotating basin; (ii) a circular basin with the pole at its centre located on a polar beta-plane. In both cases, the fluid is initially at rest and a step escarpment is imposed on the free-surface by the imposition of a vertical wall. The question we address is how does the fluid evolve upon removal of the wall?

These adjustment problems prove to be a valuable method for evaluating the performance of a pan-Arctic coupled sea ice-ocean model based on the NEMO-shelf modelling system under development at the new National Oceanography Centre operating from Liverpool and Southampton.

1B01.2 ID:3382 INVITED/INVITÉ 11:15

Why ice minima occurred in 2007, 08 and 09?

Jia Wang
NOAA Great Lakes Environmental Research Laboratory
Contact: jia.wang@noaa.gov

The record low Arctic sea ice occurred in September 2007, followed by the second lowest in 2008 and the third lowest in 2009. Although the Dipole Anomaly (DA) has been identified as the major driver, what are the mechanisms for Arctic sea ice to gradually recover? This study examines these three cases in a great detail to search for dynamic and thermodynamic sound mechanisms, along with historical observations. It comes to the conclusion that under the thin-ice preconditioning (warming) during winter season by a strong positive Arctic Oscillation (AO) in the 2009 winter, local meridional wind anomaly associated DA during winter to summer is a major forcing for sea ice recovery. Other mechanisms will be discussed

1B01.3 ID:3340 11:30

Methane and global climate change during the Paleocene-Eocene thermal maximum

David Carozza , *Lawrence A. Mysak*
McGill University
Contact: david.carozza@gmail.com

The Paleocene-Eocene thermal maximum (PETM), approximately 55 million years ago, was a period of intense climate change that occurred over a 200 kyr period that was associated with the release of unprecedented amounts of light carbon to the ocean-atmosphere system. This event is documented by large negative carbon isotope excursions in oceanic and terrestrial environments and by other environmental changes, and is considered to be the most analogous climate event (in terms of the magnitude of the carbon release) to anthropogenic climate change in the Earth's geological history. Models of the Earth system have been used to estimate the amount of carbon released during the PETM with the goal of diagnosing its cause. However, differences in the models and proxies used in such studies have led the estimated carbon emission to range from 840 to 6800 Pg C. Due to its 13C-depleted isotopic composition and strong atmospheric radiative forcing, methane is thought to have played a pivotal role during the PETM. In this study, the two-box atmospheric methane model due to Schmidt and Shindell is coupled to the carbon cycle box model of Walker and Kasting and tuned to the background state of the PETM. A wide range of atmospheric and oceanic emission scenarios representing different amounts and isotopic content of emitted methane and carbon dioxide are then simulated. The results are compared to the PETM carbon isotope record and proxies for lysocline shoaling and atmospheric radiative forcing, and are used to derive a range of the most likely emission scenarios. These simulations lead to an improved evaluation of the amount of carbon emitted and the carbon source, and thus the cause of the PETM.

1B01.4 ID:3890 11:45

Multiple equilibria and abrupt climate change in coupled aquaplanet simulations

Brian Rose , *David Ferreira* , *John Marshall*
Massachusetts Institute of Technology
Contact: brose@mit.edu

A coupled atmosphere-ocean-sea ice GCM is used to explore the climates of Earth-like planets with idealized ocean basin geometries. We find three stable equilibria under identical external forcing: a warm ice-free climate, a cold climate with mid-latitude ice edge, and a completely ice-covered "snowball" state. These multiple states persist for millennia with no drift despite a full seasonal cycle and vigorous internal variability of the system on all time scales. The behaviour of the coupled system is rationalized through an extension of the classic energy balance model (EBM) to include meridional structure in the ocean heat transport (OHT), and the insulation of the ice- covered sea surface. With these two key properties, the EBM supports a stable large ice cap in addition to the warm and snowball states. The modified EBM thus provides a minimal model for understanding the crucial role of meridional structure in the OHT in supporting multiple equilibria, while the GCM results indicate that multiple states can exist even in the presence of a full seasonal cycle, weather noise and other complexities. Finally, long GCM simulations with a slowly varying external parameter show that the transitions in and out of the ice-free state are abrupt,

with polar ice appearing and disappearing in under 20 years. These transitions have the characteristics of the small ice cap instability familiar from EBMs. We speculate on the implications of these findings for understanding the paleoclimate record.

1B01.5 ID:4020 INVITED/INVITÉ 12:00

On the role of North Atlantic sea ice displacements in Dansgaard-Oeschger cycles

Camille Li [1], *David S. Battisti* [2], *Cecilia M. Bitz* [2], *Trond M. Dokken* [3], *Kerim H. Nisancioglu* [3]

[1] (1) Bjerknes Centre for Climate Research, (2) University of Bergen
[2] University of Washington
[3] Bjerknes Centre for Climate Research
Contact: camille@uib.no

Sea ice is thought to be a principal player in Dansgaard-Oeschger (D-O) cycles, the millennial scale climate cycles that are a prominent feature of North Atlantic paleoclimate records throughout much of the last glacial period. Although some observational evidence exists to support this idea, it is not sufficient to constrain the exact characteristics of or mechanism behind sea ice displacements in D-O cycles. More high resolution data in more locations combined with focused modelling studies is needed. Here, we provide an overview of some modelling and observational work aimed at resolving these open questions. A recent multi-proxy analysis of a high-resolution marine core on the Norwegian slope suggests a new hypothesis for D-O cycles in which a series of interactions between the ocean and cryosphere alternately builds and erodes a fresh surface halocline in the Nordic Seas over millennial times scales, promoting sea ice displacements and a toggling of climate between the cold and warm phases of D-O cycles. A combination of coupled model simulations and uncoupled sensitivity experiments is used to establish seasonality and geographical constraints on the type of sea ice displacements necessary to produce a climate response consistent with the D-O signatures recorded in this and other paleoclimate archives. The modelling results point to the importance of winter sea ice displacements in the Nordic Seas in particular for creating the observed temperature and accumulation signals associated with D-O cycles in the Greenland ice cores.

Uncertainty in climate change impacts to the water cycle (Part 1) / Incertitude quant

aux effets du changement climatique sur le cycle de l'eau (Partie 1)

Room / Endroit (Ballroom C), Chair / Président (Katrina Bennett), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B03.1 ID:3728 **11:00**

Development of a Climate Change Hydrologic Assessment Framework for the Province of Ontario

Sam Bellamy [1], *David Van Vliet* [1], *Robert Walker* [2], *Linda Mortsch* [3], *Mike Garraway* [4], *Lynne Milford* [4], *Shaina Collin* [1]
[1] AquaResource Inc.
[2] EBnFLO Environmental
[3] Environment Canada
[4] Ontario Ministry of Natural Resources
Contact: sbellamy@aquaresource.ca

The Province of Ontario has developed a comprehensive guidance manual for the assessment of climate change impacts on surface water and groundwater resources. This guide is aimed towards water resources engineers and hydrologists responsible for watershed-based water budget studies under the Clean Water Act (2004) as well as similar types of investigations such as subwatershed planning studies and hydrologic impact assessments. The guidelines are developed specifically to aid in the estimation of the impact of climate change on hydrologic processes relating to precipitation, evapotranspiration, runoff, and groundwater recharge.

This presentation provides a brief summary of several aspects related to the guidance document, including: the recommended guidelines which includes a methodology for representing the predictive variability of water budget parameters associated with alternative Global Climate Model scenarios; a summary of a case study; and current efforts to develop a database of climate scenarios for climate stations across the Province.

1B03.2 ID:3394 **11:15**

Trends in timing of Canadian low flows under short and long term memory assumptions

Eghbal Ehsanzadeh [1], *Kaz Adamowski* [2]
[1] Postdoctoral Researcher,National Water Research Institute, Saskatoon, SK, S7N 3H5 Canada
[2] Department of Civil Engineering, University of Ottawa, Ottawa, Ontario K1N 6N5, Canada
Contact: eehsanzadeh@gmail.com

The annual timing of river flows might indicate changes that are climate related. In this study, trends in timing of low flows for the Reference Hydrometric Basin

Network were investigated under three different hypotheses namely: independence, short-term persistence (STP) and long-term persistence (LTP). Both summer and winter time series were characterized with scaling behaviour providing strong evidence of LTP. The Mann–Kendall trend test was modified to account for STP and LTP, and used to detect trends in timing of low flows. It was found that considering STP and LTP resulted in a significant decrease in the number of detected trends. Numerical analysis showed that the timing of summer 7-day low flows exhibited significant trends in 16, 9 and 7% of stations under independence, STP and LTP assumptions, respectively. Timing of summer low flow shifted toward later dates in western Canada, whereas the majority of stations in the east half of the country (except Atlantic Provinces) experienced a shift toward earlier dates. Timing of winter low flow experienced significant trends in 20, 12, and 6% of stations under independence, STP and LTP assumptions, respectively. Shift in timing of winter low flow toward earlier dates was dominant all over the country where it shifted toward earlier dates in up to 3/4 of time series with significant trends. There are local patterns of upward significant/insignificant trends in southeast, southwest and northern Canada. This study shows that timing of low flows in Canada is time dependent; however, addressing the full complexity of memory properties (i.e. short term vs long term) of a natural process is beyond the scope of this study.

1B03.3 ID:3556 11:30

Assessing uncertainties due to climate change in the Winnipeg River Basin

Phillip Slota [1], *Tricia Stadnyk* [1], *Nicholas Kouwen* [2], *Kristina Koenig* [3]
[1] University of Manitoba
[2] University of Waterloo
[3] Manitoba Hydro
Contact: stadnykt@cc.umanitoba.ca

Recent trends toward hydrological extremes in Canada's north, and increased short-term variability have necessitated that operators and policy-makers shift from statistically-based to more physically-based hydrological models to quantify operational adaptation measures. The problem being increased uncertainty inherent to these models and the input data used to force the models. Using the WATFLOOD hydrological model, a physically-based hydrological modeling system, this research seeks to simulate streamflow in a remote, hydrologically-complex basin: the Winnipeg River Basin (WRB). Significant errors in precipitation forcing were identified and correlated with uncertainties in simulated streamflow from particular regions of the WRB where precipitation estimation seemed to be problematic. These errors were significantly reduced by adding a "region of influence" to precipitation gauges, and by examining the use of a krigging process to improve mesoscale rainfall distribution in basins where measured data are frequently sparse. The impacts of climate change on the WRB flow regime were then simulated using global climate model (GCM) data to produce monthly delta values (relative to a 1970-1999 baseline period) used to perturb historical climate records. A total of 139 GCMs are used to derive delta-

values that are read into WATFLOOD to produce forecasted climates for hydrological simulation. For each climate forecast, a 10-year simulation streamflow is performed for the 2020s, 2040s and 2080s time periods. Uncertainties in climate model simulations are then assessed by comparing the variability among the projected climates. Hydrological variability in the 2020s, 2040s and 2080s is forecasted for the WRB by examining the range in WATFLOOD- simulated flows produced by the 139 climate predictions. Hydroelectric power production requires a detailed understanding of regional flow trends. In light of global climate change, it is beneficial for operational hydrologists to understand the effects of climate change on flow regimes to better plan and adapt future management and operational procedures.

1B03.4 ID:4012 **11:45**

Sensitivity of Projected Streamflow Changes in a Small Coastal Hybrid Watershed to Selected GCMs, Emissions Scenarios, Model Runs and Downscaling Approaches

Arelia Werner , *Katrina Bennett* , *Markus Schnorbus*
Pacific Climate Impacts Consortium
Contact: wernera@uvic.ca

Uncertainty in projected streamflow is contributed throughout multiple levels of the modelling process including GCM selection and downscaling. GCM variability is dependent on the selected models, emissions scenarios and run members, which all contribute fractions of the overall range in future change in streamflow. How much of the response is driven by these four factors? And at which timescales does each component play a role? The Campbell River watershed, a 1,500 km2 watershed, located on Vancouver Island in the southwest BC will serve as a test case. It is a coastal watershed with a mixed rainfall and snowmelt, or hybrid, regime. Potential consequences of climate change to this watershed include shifting from a hybrid to rainfall-dominated regime by losing streamflow contributions from snowmelt. Here, temperature and precipitation projections have a nearly linear relationship, likely due to the strong climatic gradient created in this region by frontal systems. Projected decreases in summer precipitation are high relative to other parts of the Province, with decreases of up to -40% accompanied by temperatures increase of up to +4oC depending on GCM, emissions scenario and run member. Streamflow changes were assessed with Variable Infiltration Capacity (VIC) model forced with 17 BCSD-scenarios using 7 GCMs and 3 emissions scenarios (A2, A1B and B1) downscaled with the Bias-Correction Statistical Downscaling technique and 15 delta-scenarios created with 5 runs of CGCM3 run under A2, A1B and B1. The sensitivity of the projected changes in streamflow to GCM, emissions scenario, run member and downscaling approach will be quantified to provide context for applications of these results to management and planning.

1B03.5 ID:3927 **12:00**

Uncertainties in the assessment of climate change impacts at the watershed level using Canadian RCM projections: The Peace River Basin, BC

Marco Braun [1], *Katrina E. Bennett* [2], *Laxmi Sushama* [1], *Daniel Caya* [3]
[1] Université du Québec à Montréal - UQÀM
[2] Pacific Climate Impacts Consortium - PCIC, Victoria, Canada
[3] Consortium Ouranos - Montréal, Canada
Contact: Braun.Marco@sca.uqam.ca

Regionalization of impacts remains a challenge in the response to global climate change. Global measures of reduction of green house gas emissions need to be paralleled by the elaboration of adaptation measures at the regional and local scale. In particular, changes to water balance components both in amount and distribution affect the water and energy sector at the watershed level and require the assessment of changes and impacts at this scale. Regional climate models (RCM) with their complete closed water budget provide realistic projections of climate change impacts on water resources and can be used to assess the climate change signal on specific drainage basins. Prudent use of such assessment needs to take into account the uncertainties involved in producing this kind of regional projections. We investigate three sources of uncertainty reflected in climate change projections of the Canadian RCM (CRCM) produced for the Peace River above Taylor in British Columbia. First, the impact of the internal variability of the CRCM on climate change projections at the watershed level is quantified. Second, the natural variability of the climate system and its implication for watershed level climate change projections is shown. This includes the effect of the choice of future and reference time period. Finally, the watershed sizes impact on the certainty of the statistics due to the number of CRCM grid cells available for analysis is addressed. This effect is demonstrated using the sub watersheds of the upper Peace River basin. Future CRCM projections at higher spatial resolution may mitigate the third source of uncertainty. This is shown using preliminary results from higher resolution CRCM simulations.

1B03.6 ID:3630 12:15

Downstream integration of streamflow response to climatic variability in a complex Cordilleran environment: Fraser River Basin, B.C.

Robin Thorne , *Ming-ko Woo*
McMaster University
Contact: thornerf@mcmaster.ca

Pacific North America is known to be influenced by climatic cycles associated with the ENSO (El Niño-Southern Oscillation). These cycles often give rise to inter-annual variations of air temperature and precipitation, which in return are expected to generate streamflow variability. However, the response of streamflow to ENSO events is complicated by land characteristics, including location, topography and basin storage. The non-climatic effects are amplified in

a rugged environment such as the Western Cordilleras, in which the Fraser River basin is situated. Streamflow along the Fraser River was analysed in conjunction with temperature and precipitation to examine how strongly the flow reflects the ENSO signal. Results indicate that winter precipitation, along with May and June temperatures show a significant connection to ENSO, but such a correlation is not conveyed to all hydrometric stations in the Fraser system. The main trunk Fraser River is significantly correlated to ENSO during the summer months while its tributaries have mixed responses. Following the river downstream, the flow records suggest that the ENSO signal is masked by local effects in headwater catchments, but as the basin size increases, local anomalies are subsumed under regional effects of ENSO. Thus, within the domain of the Fraser Basin, local effects represent noises of various intensities superimposed onto the regional climate signal, causing spatial uncertainties in the climate-streamflow relationship. Nevertheless; for the basin as a whole, the signal is robust enough to permit quantitative correlation between climate variability and outflow from the large river system.

Coupled Atmosphere-Ocean Prediction and Predictability (Part 1) / Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 1)

Room / Endroit (Richelieu), Chair / Président (C. Harold Ritchie), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B04.1 ID:3439 11:00

Impact of model uncertainty on seasonal forecast quality: the ENSEMBLES project

Francisco Doblas-Reyes
Institut Català de Ciències del Clima (IC3)
Contact: f.doblas-reyes@ic3.cat

Three techniques to represent model uncertainties and generate ensembles for dynamical seasonal forecasting have been explored in the European-Union funded ENSEMBLES project: multi-model ensemble, perturbed parameters and stochastic physics. These three techniques try to overcome with different approaches the impact of model uncertainty on forecast error. In order to compare the different approaches and to assess their relative merits, a common set of seasonal forecast experiments was defined, covering the period 1960-

2005 with four start dates per year, has been defined. The well-known advantages of the multi-model approach, such as the reduction of probability forecast overconfidence, will be illustrated. A thorough comparison of the forecast quality between the multi-model and the two other approaches will be used to show that the perturbed-parameter an stochastic-physics ensembles can be competitive when the typically larger ensemble size of the multi-model is taken into account. Besides, the impact of the stochastic-physics approach to reduce the systematic error of the reference GCM and improve the spread of the ensemble will also be discussed. Results for specific areas such as Africa, Europe and North America will be used as examples.

1B04.2 ID:3658 11:30

The CCCma sub-seasonal to decadal forecasting system

William Merryfield [1], *Woo-Sung Lee* [1], *George Boer* [1], *Greg Flato* [1], *Slava Kharin* [1], *John Scinocca* [1], *Badal Pal* [1], *Youmin Tang* [2], *Aaron Berg* [3], *Gordon Drewitt* [3], *Saroja Polavarapu* [4]
[1] Canadian Centre for Climate Modelling and Analysis
[2] University of Northern British Columbia
[3] University of Guelph
[4] Environment Canada
Contact: bill.merryfield@ec.gc.ca

A core goal of the Global Ocean-Atmosphere Prediction and Predictability (GOAPP) research network has been to develop a coupled model-based climate prediction system for Canada that exploits available climate predictability on timescales ranging from a season or less to a decade or longer. This goal has been realized owing to GOAPP-enabled research and development directed toward improving and assimilating observational data into the CCCma climate model, producing retrospective forecasts to enable skill assessment, and post-processing to enhance forecast skill.

This overview talk will briefly describe

- multi-model aspects of the forecast system, which employs CCCma climate model versions CanCM3 and CanCM4

- initialization strategies for the ocean, atmosphere, land and sea ice

- sub-seasonal to decadal retrospective forecasts

- contributions to international research activities, including the World Climate Research Program (WCRP) Climate-system Historical Forecast Project (CHFP) and the Intergovernmental Panel of Climate Change (IPCC) 5th Assessment

- steps taken to enable operational use

1B04.3 ID:3959 11:45

Decadal potential predictability of forced and internally generated variability in the 21st century

George Boer
Canadian Centre for Climate Modelling and Analysis
Contact: george.boer@ec.gc.ca

The 21st century is experiencing both anthropogenic climate change and internally generated natural variability. A forecast for the next decade must include both components. The relative importance of the two components for temperature and precipitation and an indication of their decadal predictability is obtained from a multi-model analysis of simulations in the CMIP3 data archive.

1B04.4 ID:4000 12:00

The second Coupled Historical Forecasting Project (CHFP2)

Woo-Sung Lee, *William J. Merryfield*
Canadian Centre for Climate Modelling and Analysis
Contact: WooSung.Lee@ec.gc.ca

Research under the Global Ocean-Atmosphere Prediction and Predictability research network (GOAPP) has led to development of a coupled multimodel climate forecast system at CCCma. Here we describe results from a large set of multiseasonal retrospective forecasts, the second Coupled Historical Forecasting Project (CHFP2), which are comprised of 12-month ensemble forecasts spanning 1979-2008. Forecast skills for ENSO and other climate variables are compared against those of the initial CHFP1 pilot project, as well as Environment Canada's current two-tier operational system, and comparative impacts of model and initialization improvements on forecast skill are discussed.

1B04.5 ID:3642 12:15

Measuring Prediction Utility of Seasonal Predictions of Asian Summer Monsoon in a Coupled Model

Dejian Yang [1], *Youmin Tang* [1], *Yaocun Zhang* [2]
[1] Environmental Science and Engineering, University of Northern British Columbia, Canada
[2] School of Atmospheric Sciences, Nanjing University, China
Contact: yangd@unbc.ca

Using the retrospective ensemble forecasts from the National Centers for Environmental Prediction (NCEP) coupled atmosphere-ocean Climate Forecast System (CFS), we explored the prediction utility of two dynamical summer monsoon indices, and their relationship with actual prediction skills measured by the contribution of correlation skill (C). The prediction utility is here measured by relative entropy (RE) introduced recently from information theory. The result

shows that RE is a good indicator of C for both indices. Further analysis reveals that the normalized ensemble mean shift (NEMS), an element of RE, dominates the relationship between C and RE, and has a better correlation with C than RE. The reason why NEMS dominates the RE-C relationship is illustrated in a simple framework. In addition, the possible reason for the difference in the RE-C relationship between the two indices is explored.

Interactions Among Biogeochemical Cycles (Part 1) / Interactions entre les cycles biogéochimiques (Partie 1)

Room / Endroit (Frontenac), Chair / Président (Richard Bourbonniere), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B05.1 ID:4038 INVITED/INVITÉ 11:00

Connecting ecohydrological and biogeochemical controls on elemental cycling in soils and sediments- methane dynamics as example

Christian Blodau
University of Guelph
Contact: cblodau@uoguelph.ca

Fluxes of elements and species from aquatic and semi-aquatic systems can be viewed as hierarchically controlled. In this view, ecosystem structures sets a framework for hydrological processes, which regulate energetic, kinetic, and stoichiometric controls on biogeochemical processes. The presentation will (I) provide conceptual insight in the nature and effectiveness of fundamental controls on biogeochemical processes, with particular reference to methane production in wetland ecosystems. Methane production is particularly suited for this analysis because it is an obligatory anaerobic process that is energetically and kinetically little competitive compared to other anaerobic respiration processes, and because it furthermore affected by specific stoichiometric and toxic limitations of methanogenic archea. For energetic reasons methane production is typically limited when electron acceptors, such as sulphate or humic substances, are abundant and it can be strongly activated when electron acceptors are depleted. The regulation of methane production thus provides a prime example for the connection of elemental cyles via flow of energy and for their regulation by hydrologic processes. Moving to a higher hierarchical level, the presentation will (II) illustrate how hydrologic forcing can set ecosystem structure changes in motion that result in a greatly decreased biogeochemical potential of a wetland ecosystem to produce methane. Potential reasons are

identified based on an analysis of the involved microbial processes and geochemical controls.

1B05.2 ID:4044 11:30

Mercury-DOC dynamics in runoff during storm events in a Boreal Precambrian Shield catchment

Claire Oswald [1], *Brian Branfireun* [1], *Andrew Heyes* [2]
[1] University of Toronto (Mississauga)
[2] University of Maryland Chesapeake Biological Lab
Contact: claire.oswald@utoronto.ca

Mercury (Hg) emitted from industrial sources has resulted in Hg-contamination of remote aquatic ecosystems. Although there is strong movement to regulate these sources, uncertainty surrounding the release of historically-deposited Hg that has accumulated in soils presents a regulatory challenge. Hydrological processes are expected to exert a major control on the timing and magnitude of the boreal upland response to changes in Hg loading. This paper focuses on the hydrological controls on Hg-DOC (dissolved organic carbon) dynamics, in particular during storm events, in the METAALICUS (Mercury Experiment to Assess Atmospheric Loading in Canada and the U.S.) experimental catchment in northwestern Ontario. A comparison of multiple storm events with different runoff responses reveals that antecedent water storage deficits in large, soil-filled bedrock depressions exert a primary and predictable control on runoff generation by regulating subwatershed hydrologic connectivity. Our findings also show that the surface organic soil horizons dominate the soil Hg pool, and are dynamic in terms of Hg release into soil water. Thus, the boreal shield landscape topography enhances the flushing of DOC and associated Hg from this near-surface zone via the fill-and-spill process, especially during periods with minimal storage deficits. However, in 2008, a storm event after a long dry period yielded the same total mass of Hg in runoff as a much larger storm with wetter antecedent conditions. This difference suggests that biogeochemical processes, such as the decomposition of soil organic matter, dominate over hydrological processes in the release of Hg from soils after dry periods and may play an important role in regenerating the pool of mobile Hg in the catchment.

1B05.3 ID:3835 11:45

Potential contributions of streamflow variability and concentration-discharge shifts to watershed mercury sensitivities in Precambrian Shield headwater landscapes.

Murray Richardson , *Brian Branfireun*
University of Toronto, Department of Geography
Contact: murray_richardson@carleton.ca

This study examined the potential for future changes in boreal watershed

mercury (Hg) sensitivity in response to climate-mediated shifts in terrestrial-aquatic solute export. A concentration-flux-discharge (CFQ) analysis for 10 gauged watersheds in the Muskoka-Haliburton region of south-central Ontario was conducted using a daily streamflow record and a weekly to biweekly chemistry monitoring database for the 20 year period between 1980 and 2000. Lacking any historical Hg data, only 4 proxy solutes known to strongly influence the movement, transformation and bioaccumulation of Hg in boreal watersheds were analyzed: DOC, colour, sulphate and hydronium ion. The CFQ analyses revealed that changes in streamflow volume was a dominant factor governing total annual terrestrial-aquatic fluxes of these solutes, but that shifts in concentration-discharge (CQ) relationships (a proxy for terrestrial biogeochemical dynamics) accounted for a significant proportion of the observed annual deviations from longterm mean annual fluxes (75%,68%,55%,40% respectively for sulphate, hydronium, DOC, and colour). Forested wetlands influenced interannual variability of annual DOC, colour and sulphate fluxes and the relative contributions of CQ shifts to observed variability. An analysis of Hg concentrations in yearling yellow perch at two headwater lakes revealed a strong, positive linear correlation between total annual terrestrial-aquatic flux of sulphate, hydronium ion and Hg residue in yearling perch, but only in the wetland dominated lake basin. Overall these various lines of evidence indicate strong potential for climate-mediated shifts in future watershed mercury sensitivity in certain lake basins, primarily in response to short-term terrestrial sulphate dynamics or potentially correlated variables such as acidity or MeHg export. However, the results give rise to numerous additional questions regarding the hydrological, biogeochemical and ecological interactions driving MeHg uptake into food webs and their sensitivities to climatic and physiographic variables in this region.

1B05.4 ID:3967 **12:00**

Methylmercury Dynamics in Relation to Decreasing Atmospheric Sulphate Deposition in an Experimental Wetland

Carl Mitchell [1], *Jill Coleman-Wasik* [2], *James Almendinger* [2], *Steven Balogh* [3], *Brian Branfireun* [4], *Susan Eggert* [5], *Daniel Engstrom* [2], *Angela Hong* [1], *Jeff Jeremiason* [6], *Randy Kolka* [5], *Bruce Monson* [7], *Edward Swain* [7]
[1] University of Toronto - Scarborough
[2] St. Croix Watershed Research Station
[3] Metropolitan Council Environmental Services
[4] University of Toronto - Mississauga
[5] USDA Forest Service
[6] Gustavus Adolphus College
[7] Minnesota Pollution Control Agency
Contact: carl.mitchell@utoronto.ca

Mercury and sulphur cycles are closely linked in wetland environments. In ombrotrophic wetlands, the load of atmospherically deposited sulphate is a strong control on the activity of sulphate-reducing bacteria. In turn, sulphate-reducing bacteria are largely responsible for the transformation of

atmospherically deposited inorganic mercury into methylmercury. This is an ecologically important linkage because methylmercury is biomagnified through aquatic foodwebs and bioaccumulates in biota. With the intent of further elucidating the relationship between sulphur and mercury cycles in wetlands, we sought to determine how methylmercury production and accumulation are affected by decreased atmospheric sulphate deposition, such as has been observed with sulphur emissions regulations. We adopted a large-scale peatland manipulation design, wherein sulphate deposition was experimentally increased for four full years in half of a 2.4-hectare ombrotrophic peatland through the use of a rainfall simulator. After four years, sulphate additions were ceased on one third of the experimental treatment, but continued on the remainder of the experimental treatment for an additional three years. Chronic increases in sulphate deposition led to significant increases in methylmercury production and accumulation in pore water and peat compared to the control half of the experimental wetland. Middle peatland areas were more strongly affected by changes in sulphate deposition than the outer margins of the peatland, presumably in relation to differences in hydrological connectivity with the surrounding upland forest. Of particular significance, once sulphate additions ceased, methylmercury concentrations in pore water and peat, as well as total mercury concentrations in predaceous beetle larvae, returned to background levels in less than three years. These findings have potentially important policy implications regarding mercury pollution and exposure control through the regulation of multiple atmospheric pollutants.

1B05.5 ID:3770 12:15

Redox Buffering and Calcite Precipitation in Calcareous Fens: Constraints on Phosphorus Availability

Tim Duval [1], *Mike Waddington* [1], *Brian Branfireun* [2]
(Presented by *Timothy Duval*)
[1] School of Geography and Earth Sciences, McMaster University
[2] Dept. of Geography, University of Toronto at Mississauga
Contact: duvaltp@mcmaster.ca

Calcareous fens are minerotrophic peatlands that exhibit very high species diversity. The scarcity of phosphorous in the fen pore water is generally considered the principal cause of high species richness. However, the mechanisms responsible for low phosphorous concentrations have been debated. This study reveals that it is a combination of processes, both biogeochemical and hydrological, that contributed to low phosphate concentrations in three calcareous fens in southern Ontario. Pore water phosphate concentrations were generally low, averaging 16.5 mcg/L, but varied across the sites and with depth in the peat. Delivery of phosphate was primarily through surface water connections, with stream stage controlling these dynamics. This aerobic stream water contained elevated nitrate levels (mean 2.25 mg/L-1 nitrate-N) and the delivery of electron acceptors to the peat provided redox buffering against iron reduction, rendering phosphate unavailable along

this declining redox gradient. In areas of low redox potential, hydrogen sulphide production led to plant toxicity; thus, plants could not utilize the redox-mediated liberation of phosphate. Additionally, calcium levels were generally high enough to promote calcite precipitation in the peat, leading to the co-precipitation of phosphate as apatite, but standard chemical analytical techniques overestimated the bioavailable fraction of the pore water phosphate pool. The spatially distributed availability of phosphate, caused by the interaction of biogeochemical cycles and hydrological flowpaths, was related to the species distribution.

Climate change and the carbon cycle (Part 1) / Le cycle du carbone et les changements climatiques (Partie 1)

Room / Endroit (Joliet), Chair / Président (Nathan P Gillett), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B06.1 ID:3920 INVITED/INVITÉ 11:00

Ensemble reconstruction constraints on the global carbon cycle sensitivity to climate

David Frank [1], *Jan Esper* [2], *Christoph Raible* [3], *Ulf Büntgen* [1], *Valerie Trouet* [1], *Benjamin Stocker* [3], *Fortunat Joos* [3]
[1] Swiss Federal Research Institute WSL
[2] Johannes Gutenberg University
[3] University of Bern
Contact: david.frank@wsl.ch

The processes controlling the carbon flux and storage of the atmosphere, ocean, and terrestrial biosphere are temperature sensitive and are likely to provide a positive feedback leading to amplified anthropogenic warming. Due to this feedback, at interannual to Milankovitch timescales, warming of the climate system causes a net release of CO_2 into the atmosphere; this in turn amplifies warming. But the magnitude of the climate sensitivity of the global carbon cycle - termed γ- and thus of its positive feedback strength, is under debate, giving rise to large uncertainties in global warming projections. In this talk, I will present recent work based on coupling a probabilistic approach with an ensemble of proxy-based temperature reconstructions and pre-industrial CO_2 data to provide robust constraints for γ on the policy-relevant multi-decadal to centennial timescales. We quantify the median γ to 7.7 ppmv CO_2/°C warming with a likely range of 1.7 - 21.4 ppmv CO_2/°C. Sensitivity experiments exclude significant influence of pre-industrial land-use change on these estimates. By employing an ensemble of >200,000 members, quantification is not only improved, but

likelihoods can be assigned, thereby providing a benchmark for model simulations. Although uncertainties do not presently allow exclusion of γ calculated from any of ten coupled carbon-climate models, we find that γ is about twice as likely to fall in the lowermost rather than uppermost quartile of their range. Our results are incompatibly lower ($p<0.05$) than recent pre-industrial empirical estimates of ~40 ppmv CO_2/°C and correspondingly suggest ~80% less potential amplification of ongoing global warming.

1B06.2 ID:3812 11:30

Investigating the natural carbon cycle since 8 kyr BP using an intermediate complexity model

Christopher Simmons [1], *Lawrence Mysak* [1], *Damon Matthews* [2]
[1] McGill University
[2] Concordia University
Contact: christopher.simmons@mail.mcgill.ca

The early anthopogenic hypothesis suggests that part of the 20 ppm rise in atmospheric CO2 concentration between 8 kyr BP and the present can be explained by early human land-use change. In this study, the University of Victoria Earth System Climate Model (UVic ESCM) v. 2.9, containing a fully-coupled atmosphere-ocean-terrestrial-sediment carbon cycle, is employed to investigate whether an external forcing mechanism is necessary to reproduce the mid- and late-Holocene trend in the atmospheric CO2 concentrations observed in ice cores. The UVic model was equilibriated for 5000 model years with solar forcing, CO2 concentrations, and land ice for 8 kyr BP, which was subsequently used to initiate transient simulations covering the full period from 8 kyr BP to the present. These experiments were performed with dynamic natural vegetation under both prescribed CO2 and for an unconstrained, freely-evolving carbon cycle. The model results in the free carbon run demonstrate an initial increase in atmospheric CO2 by 5-10 ppm in the first 2000 years of the simulation, closely reflecting observations, but then declined below their original mid-Holocene level rather than following the observed CO2 trend. Furthermore, in the prescribed CO2 simulations the global carbon reservoir grows significantly (carbon is thus not conserved), suggesting that a source outside of the model's natural carbon cycle is contributing to the observed increase in atmospheric CO2. Therefore, the results from the UVic ESCM suggest that terrestrial carbon changes (of which human land-use change may be part) and ocean feedbacks not represented in the model have contributed significantly to the observed Holocene rise in atmospheric CO2.

1B06.3 ID:3650 11:45

Effects of afforestation on simulated climate and carbon budget of the 21st century

Vivek Arora [1], *Alvaro Montenegro* [2]
[1] Canadian Centre for Climate Modelling and Analysis, Environent Canada

[2] Department of Earth Sciences, St. Francis Xavier University
Contact: vivek.arora@ec.gc.ca

Afforestation is seen as a viable climate change mitigation strategy. Afforestation causes cooling due to carbon sequestration by afforested trees which draw down CO2 from the atmosphere but also warming since forests have lower albedo than the crops and grasses they replace. The net temperature effect of afforestation broadly depends on where afforestation occurs – in tropical, mid-latitude or high-latitude regions. Here, we show results from afforestation experiments performed with the Canadian Centre for Climate Modelling and Analysis (CCCma) first generation Canadian Earth System Model (CanESM1) that simulates CO2 as a prognostic variable. 100% and 50% afforestation simulations are performed for the 2011-2100 period, where crop area everywhere in year 2010 is gradually replaced by forests by year 2060 and land cover is held constant for the 2061-2100 period. In contrast to existing studies, where complete climate model grid cells are assumed to be covered by forests instantaneously for simulating afforestation, we gradually afforest trees over a 50-year period and only over the crop area fraction of the grid cells. Globally averaged temperature is reduced by around 0.4 and 0.25 degrees Celsius in simulations with 100% and 50% afforestation, primarily in response to lower atmospheric CO2 concentrations of 93 and 45 ppm by year 2100, than in the reference no-afforestation case, due to CO2 uptake by afforested trees. Temperature, however, increases in the mid- to high-latitudes regions where the local albedo effect exceeds the global cooling effect. The global temperature reductions are, however, only marginal. Even the 50% afforestation scenario is possible only when humans achieve doubling of crop yield and the global population does not change. The implication is that while afforestation yields numerous other environmental benefits its climate/temperature benefits are only marginal.

1B06.4 ID:3414 12:00

Improving CBM-CFS3 forest carbon predictions: reducing decay rates in limited moisture conditions

Carolyn Smyth , *Werner Kurz* , *Tony Trofymow*
Natural Resources Canada
Contact: carolyn.smyth@nrcan.gc.ca

Decomposition of plant detritus and humified organic matter in terrestrial ecosystems is a primary source of atmospheric carbon dioxide, yet the dynamics of decomposition are not well understood, in particular its response to climate.

In this study, modeling of forest litter decomposition was improved by reducing decay rates under limited moisture conditions, as determined by comparison of model predictions with data from a 12-year national litterbag study - the Canadian Intersite Decomposition Experiment (CIDET). The model, the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) is the model used to produce annual reports on greenhouse gas emissions and removals in Canada's managed forests. The CBM-CFS3 presently simulates the decomposition of dead organic matter pools using decay rates that are modified by regional mean annual temperature, but not moisture conditions.

A water stress modifier was developed to reduce decay rates under limited moisture conditions. Several simple water stress modifiers based on precipitation and potential evapotranspiration were tested, and parameters were simultaneously fit by minimizing the least-squared error between model predictions and litterbag 12-yr time series. The best water stress formulation used the average of the ratio of monthly precipitation to monthly potential evapotranspiration, and increased the explained variance by 9%. Accounting for the water stress increased decay rates in non-water stressed locations, which suggested that previous decay rate estimates were biased low due to reduced decay rates at dry locations.

Decomposition water stress modifiers were applied to two case studies: stand simulations representing 11 forest management units in the dry British Columbia interior and for roughly 500 plots from a national soil plot database. The addition of the water stress modifier modestly increased litter and humified organic matter carbon stocks at dry locations and decreased stocks at non-water stressed locations.

Although limited to leaf litter only, this study provided insight into how water stress affects carbon stocks and stock changes. The ability to lower decay rates of certain dead organic matter pools under limited moisture conditions in the CBM-CFS3 has the potential to reduce bias in carbon flux predictions for dry regions and for future climate change scenarios where moisture limits decomposition processes.

1B06.5 ID:3701 12:15

Modeling Crop Phenology in a Process-based Land Surface Scheme: CN-CLASS

Kuo-Hsien Chang [1], *Jon Warland* [1], *Paul Bartlett* [2], *M. Altaf Arain* [3], *Paul Voroney* [1], *Claudia Wagner-Riddle* [1], *Fengming Yuan* [4]
[1] School of Environmental Sciences, University of Guelph
[2] Climate Research Division, Environment Canada
[3] School of Geography and Earth Sciences, McMaster University
[4] Department of Biology and Wildlife, University of Alaska
Contact: kchang@uoguelph.ca

Most of the process-based land surface schemes used in GCMs were developed based on forest phenology, such as boreal, deciduous and conifer forests. Therefore, the appropriate representation of phenology and carbon allocation for crops is not well established in land surface schemes. This study examines a new modeling mechanism incorporated in the Carbon and Nitrogen coupled

Canadian Land Surface Scheme (CN-CLASS) for crop phenology and agricultural application by simulating corn growth at an agricultural site, Elora Research Station (ERS) in southern Ontario, Canada. The use of this new crop phenology algorithm within CN-CLASS improved the prediction of dynamic root:shoot ratio, leaf growth and grain yield. A new mechanism associated with the schedule of planting, fertilization and harvest was also coupled in the model to further improve its simulations.

CN-CLASS simulated values of soil water content, soil temperature, latent and sensible heat fluxes, above-ground biomass and canopy height, which were compared with observations (e.g. soil chamber CO2 fluxes and eddy- covariance CO2 fluxes). Simulated annual carbon dynamics for each vegetation pool was also compared with our previous study conducted by the Century crop–soil model (DayCENT). Furthermore, we carried out a sensitivity analysis to evaluate the impact of leaf growth on net carbon exchange. Our preliminary results suggested that an accurate representation of crop phenology, carbon allocation and agricultural management should be incorporated in land surface schemes using in GCMs to enhance their capabilities.

Stratospheric Processes and their Role in Climate (Part 1) / Les processus stratosphériques et leur incidence sur le climat (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Paul J Kushner), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B07.1 ID:3482 INVITED/INVITÉ 11:00

Determining the impact of a well resolved stratosphere on tropospheric climate and climate change.

John Scinocca
CCCma, University of Victoria, Victoria, BC
Contact: John.Scinocca@ec.gc.ca

The impact of a well resolved stratosphere on tropospheric climate is not only a question of scientific interest but also one of practical importance. General Circulation Models (GCMs) that include a well resolved stratosphere are typically several fold more expensive than tropospheric GCMs, which have lids typically located in the lower to middle stratosphere. Tropospheric GCMs have been the

basic workhorse of the IPCC assessments and the cost of a move toward stratospheric resolving models must be balanced against other demands on modelling resources such as spatial resolution and improved representations of physical processes of the climate system. It is essential, therefore, to understand the impact or "value added" by the inclusion of a well resolved stratosphere for applications such as the IPCC assessments. In this talk I will begin with a discussion of some of the issues surrounding the comparison of tropospheric and stratospheric resolving GCMs. I will then discuss a recent study by Sigmond et al. (2008) designed to compare the Northern Hemisphere climate change response between the Canadian Middle Atmosphere model and the CCCma third generation tropospheric GCM (AGCM3). This study illustrates the difficult nature of this problem and highlights the importance of carefully controlled GCM experiments.

1B07.2 ID:3483 11:30

The influence of the basic state on the Northern Hemisphere circulation response to climate change

Michael Sigmond [1], *John Scinocca* [2]
[1] University of Toronto
[2] Canadian Centre for Climate Modelling and Analysis
Contact: sigmond@atmosp.physics.utoronto.ca

Employing a comprehensive Atmospheric General Circulation Model, we have shown in a previous study that the time-mean Northern Hemisphere (NH) winter circulation response to a CO_2 doubling perturbation depends significantly on parameterized orographic gravity wave drag (OGWD) parameter settings, which are essentially related to the strength of OGWD. A possible implication is that aspects of the greenhouse gas induced circulation response could depend directly on the formulation and internal parameters settings of the OGWD scheme. Such a result would further heighten the importance of OGWD parameterizations for climate studies and have far-reaching implications for modelled projections of future climate change.

In this study we investigate the causal relationship between OGWD and changes in time-mean NH wintertime circulation response to CO_2 doubling. This is accomplished by introducing a methodology that allows us to hold the OGWD forcing fixed to its $1xCO_2$ value when CO_2 is doubled. Employing this methodology for perturbation experiments with different strengths of OGWD, we find that the changes in OGWD forcing due to CO_2 doubling have essentially no impact on the time-mean zonal-mean zonal wind response. The primary conclusion is that the OGWD influence is limited to its impact on the $1xCO_2$ basic-state climatology, which defines the propagation characteristics of resolved waves. Different strengths of OGWD result in control basic states with different refractive properties for the resolved waves. It is shown that the action of resolved waves, and their sensitivity to such differences in the control climatology, explains essentially all of the NH wintertime circulation sensitivity identified here and in our previous study. Implications for climate change projections and climate-model development are discussed.

1B07.3 ID:3600 11:45

Separating the effects of climate change and ozone depletion/recovery on the dynamics of the Southern Hemisphere troposphere and stratosphere

Charles Mclandress [1], *Andreas Jonsson* [1], *David Plummer* [2], *Cathy Reader* [3], *John Scinocca* [2], *Michael Sigmond* [1], *Ted Shepherd* [1]
[1] Department of Physics, University of Toronto
[2] Canadian Centre for Climate Modelling and Analysis
[3] University of Victoria
Contact: charles@atmosp.physics.utoronto.ca

The Southern Hemisphere troposphere and stratosphere have undergone significant changes in recent decades as a result of stratospheric ozone depletion. As ozone recovers many of these changes are expected to reverse, but the degree to which that happens will depend upon the effects of climate change resulting from increasing greenhouse (GHG) concentrations. In order to understand the relative impact of climate change and ozone depletion/recovery on both the troposphere and stratosphere a comprehensive middle atmosphere model is required. Here we use a version of the Canadian Middle Atmosphere Model (CMAM) that is coupled to an ocean general circulation model. Three sets of transient simulations extending from 1960 to 2100 are examined: one in which GHG concentrations are held fixed at 1960 levels, a second in which ozone depleting substances (ODSs) are held fixed at 1960 levels, and a third in which both GHGs and ODSs are allowed to vary transiently.

1B07.4 ID:3573 12:00

The impact of stratospheric ozone on tropospheric circulation changes in the Southern Hemisphere: Multimodel assessment

Seok-Woo Son [1], *Edwin Gerber* [2], *Judith Perlwitz* [3], *Lorenzo Polvani* [4], *Nathan Gillett* [5], *Sparc Ccmval2 PI's* [6]
[1] McGill University
[2] New York University
[3] Univeristy of Colorado
[4] Columbia University
[5] Environment Canada
[6] Many institutions
Contact: seok-woo.son@mcgill.ca

The impact of stratospheric ozone on the tropospheric general circulation of the Southern Hemisphere (SH) is examined with a set of chemistry-climate models participating in the SPARC/CCMVal2 project. Model integrations of both the past and future climates reveal the crucial role of stratospheric ozone in the SH-summer circulation. A 1 ppmv decrease of polar-cap ozone at 50 hPa in late spring cause the jet to shift poleward about 1 degree and to intensify about 0.25

m/s per decade, and causes the southern Hadley cell to expand poleward about 0.4 degree per decade in the SH summer. These changes are systematic as poleward displacement of the jet is typically accompanied by intensification of the jet and expansion of the Hadley cell. Possible mechanisms are discussed, and overall results are compared with coupled models participating in the IPCC AR4.

While the tropospheric circulation response appears quasi-linearly related to stratospheric ozone changes, the quantitative response to a given forcing varies considerably from one model to another. This scatter partly results from differences in model climatology. It is shown that poleward intensification of the westerly jet is generally stronger in models whose climatological jet is biased toward lower latitudes, and vice versa. The possible mechanisms are discussed in the context of quasi-geostrophic zonal-mean dynamics.

1B07.5 ID:3862 **12:15**

The Effect of Ozone Depletion and Greenhouse Gas Warming on the Southern Ocean in Coupled Transient Simulations using the CMAM Middle Atmosphere Chemistry Climate Model

Cathy Reader [1], *Michael Sigmond* [2], *John Fyfe* [3], *David Plummer* [3], *John Scinocca* [3], *Theodore Shepherd* [2]
(Presented by *Mary Catherine Reader*)
[1] University of Victoria
[2] University of Toronto
[3] Canadian Centre for Climat Modelling and Analysis
Contact: cathy.reader@ec.gc.ca

As part of the C-SPARC (Canadian Stratospheric Processes and their Role in Climate) project, transient simulations were performed using the CMAM chemistry climate model, coupled to a three-dimensional ocean, for the time-period 1950-2100. One three-member ensemble includes both transient greenhouse gas (GHG) concentrations and ozone depleting substances (ODSs), according to the IPCC A1B and WMO A1 scenarios respectively. Two additional ensembles were also performed with each effect individually, i.e holding GHGs constant and allowing ODSs to evolve and vice versa.

Model studies have indicated that the tropospheric circulation changes induced by GHG warming and stratospheric ozone depletion affect the Antarctic Circumpolar Current and temperature and meridional overturning of the Southern Ocean. These simulations allow the investigation of the separate and combined effects of changing GHGs and ODSs on the Southern Ocean in a fully-interactive model for the first time.

Recent developments in airborne geophysics (Part 1) / Nouveautés en géophysique aérienne (Partie 1)

Room / Endroit (Capitale), Chair / Président (Claire Samson), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B08.1 ID:3316 **11:00**

Understanding Noise Effects on the SLUTH Method and a Comparison with Euler Deconvolution

Joshua Ulla [1], *Marc Vallée* [2], *Claire Samson* [1], *Richard Smith* [3]
[1] Carleton University
[2] Fugro Airborne Surveys
[3] Laurentian University
Contact: joshulla@gmail.com

The SLUTH method is a new tool for analysis and visualization of airborne magnetic data. It is useful in determining magnetic body parameters such as lateral and vertical position, structural index, as well as estimating the susceptibility. The SLUTH method assumes homogeneity of the magnetic field and uses its derivatives to create ray paths intercepting at a point marking the location of the source body. In order to better understand the limitations of the method, we generated synthetic data from a known source and corrupted this with 0.1, 0.5, 1, and 10 nT of random noise. The results show that, while noise in excess of 1 nT does disrupt the outputs, the method is robust for noise levels normally experienced during a survey. New displays for presenting results from the SLUTH method have been developed when multiple profile lines are processed. An example from Chibougamau, Quebec, comprising 43 parallel flight lines, shows strong correlations along magnetic highs. The new displays help to distinguish bodies of different shapes and highlight their dips and strikes. The Chibougamau data set is also used to compare the results of the SLUTH and the Euler deconvolution methods. SLUTH and Euler anomalies locate similar geological trends and the estimated depths of burial are similar. In general, there are more Euler solutions. A benefit of the SLUTH technique is the fact that the structural index is not selected a priori.

1B08.2 ID:3345 **11:15**

GeoSurv II Unmanned Aircraft System - A Solution for Geomagnetic Airborne Surveys

Paul Vv Straznicky [1], *Claire Samson* [2], *Mojtaba Ahmadi* [2], *Rafik Goubran* [2], *Trevor Pearce* [2], *Anthony Whitehead* [2], *Stephen Ferguson* [3]
[1] Carleton University M&AE

[2] Carleton University
[3] Sander Geophysics Limited
Contact: pstrazni@mae.carleton.ca

Unmanned Aircraft Systems (UAS) are increasingly being considered as cost-effective solutions for civilian applications and, particularly, various airborne surveys. In Canada, UAS might become particularly useful in geophysical prospecting of the Arctic, and regions of rough topography like the Cordillera. An UAS called "GeoSurv II" (GS II) has been under development by undergraduate engineering student teams at Carleton University Department of Mechanical and Aerospace Engineering (M&AE) for six years. The design and development has been strongly supported by Sander Geophysics Ltd. (SGL). The company also identified the UAS mission – high resolution geomagnetic surveys flown at low altitudes. The aircraft has a wingspan of 4.88 m (16 ft), mass of 90.6 kg (200 lb) and is powered by a 22.4 kW (30 hp) internal combustion engine. The prototype is currently in the initial flight testing to demonstrate the aerodynamic performance. In October 2009, an NSERC CRD (Collaborative Research and Development) grant was awarded to a group of CU researchers, with SGL as the industry partner. The research program is composed of five projects that embody the key technologies associated with the GS II mission, namely Autonomous Operations, Obstacle Detection, Magnetic Signature Control, Geomagnetic Data Acquisition and Low Cost Composite structures. With the required technologies being developed and implemented, the undergraduate and graduate students will collaborate to bring GS II close to the operational status over the next three years. The paper will briefly describe the objectives, features and status of GS II, and future plans. It will then focus on the details of magnetometer installation and of magnetic signature control.

1B08.3 ID:3541 11:30

Airborne gravity for mineral and hydrocarbon exploration: Examples of Falcon airborne gravity gradiometer surveys

Jean Lemieux , *Adam Shales*
Fugro Airborne Surveys
Contact: ashales@fugroairborne.com

The Falcon airborne gravity gradiometer is the result of a collaborative project between BHP Billiton and Lockheed Martin. Specifically designed for airborne use, Falcon delivers low noise gravity data at a resolution significantly greater than conventional airborne gravimetry. Previously used exclusively by BHP Billiton or with their exploration partners, Falcon is now available worldwide and is a useful tool for both mineral and hydrocarbon exploration. This paper will review a series of examples of Falcon surveys applied in both mineral and petroleum exploration programs and will feature the results of a recent survey flown north of Timmins, Ontario, in an area surrounding the Kidd Creek mine.

1B08.4 ID:3607 **11:45**

Advancements in helicopter-borne multi-component time-domain EM systems: Examples of HeliGEOTEM surveys

Diana Johnson , *Greg Hodges*
(Presented by *Jean Lemieux*)
Fugro Airborne Surveys
Contact: ashales@fugroairborne.com

Fugro's HeliGEOTEM system is currently the world's most powerful helicopter-borne time-domain electromagnetic system having a transmitter dipole moment of 1.2 million Am2. The high power of HeliGEOTEM, coupled with the low noise at the receiver due to its placement above and not in the centre of the transmitting loop, ensures the greatest depth of exploration possible for any existing airborne electromagnetic system. Fugro's HeliGEOTEM provides measurements in X, Y, and Z receiver coils for both dB/dt and B-Field. Multi-component measurements allow more complete and definitive interpretation of conductors, and allow for the discrimination of conductors by orientation. The high quality B-Field measurements de-emphasize the conductive overburden response while enhancing the response of strong bedrock conductors. We will present and discuss examples of HeliGEOTEM surveys over Canadian mineral exploration targets.

1B08.5 ID:4609 **12:00**

AIRGrav Airborne Gravity

Stephan Sander , *Martin Bates* , *Stefan Elieff* , *Luise Sander*
Sander Geophysics
Contact: stephans@sgl.com

Recent improvements in the AIRGrav airborne gravity system have resulted in a significant reduction in airborne gravity noise levels. Standard processing techniques have proven successful at extracting gravity data from the very dynamic aircraft environment where accelerations can reach 1 m/s2, equivalent to 100,000 mGal. High precision differential GPS processing techniques and a robust gravimeter system result in final processed gravity grids with noise estimates of 0.1 to 0.3 mGal with a resolution of 2 kilometres. In this presentation, five short case studies will be shown to illustrate improvements to the AIRGrav data accuracy and resolution resulting from modifications to standard processing techniques and acquisition parameters. Case Study #1 – Hydrocarbon exploration project. An airborne survey for hydrocarbon exploration was flown using the AIRGrav system installed in one of SGL's Cessna Grand Caravans. The survey consisted of north-south oriented survey lines spaced at 500 m, with orthogonal control lines spaced at 2,500 m. A smooth drape surface was flown with a target clearance of 150 m above ground level. The survey was flown at a nominal ground speed of 105 knots (194 km/hr), which is equivalent to 54 m/s. Data from this project was processed using standard techniques as well as with new enhanced processing and the resulting data sets are compared. Case Study #2 – Using horizontal gravity components for geodetic applications. A 550 kilometre long continuous test line was flown from 20 kilometres south-east of Ottawa, Canada to the eastern shore of Lake Huron with the AIRGrav system installed in a Cessna Grand Caravan. The test successfully determined that the horizontal gravity components can be measured with high repeatability using the AIRGrav system and the measured horizontal components agree well with geoid models of the highest order available when terrain effects are removed. Case Study #3 – Mineral exploration project. Airborne gravity data have traditionally been used to define regional scale geology for which standard acquisition parameters using a fixed wing aircraft were adequate. However for mineral exploration, a higher resolution data set is preferable. Recently, the AIRGrav system was installed in a helicopter and six small survey blocks were flown at an extremely slow acquisition speed (30 knots or 56 km/hr) with tight (50 m) line spacing. Scanning laser data were concurrently acquired in order to create a high resolution 1 m grid cell size digital terrain model. This configuration coupled with the enhanced processing technique resulted in a gravity data set that met the requirements of this mineral exploration project with an accuracy of 0.4 mGal at a 300 m resolution. Case Study #4 – Scientific Research Project. The AIRGrav system was chosen for scientific use after comparison test flights in which data was simultaneously acquired using a CMG GT-1A gravimeter and the AIRGrav system. This led to the 2008-2009 AGAP project where the AIRGrav system was flown in a Twin Otter from a field camp on the Antarctic ice sheet. The data collected is being used to better understand the geologic origin and tectonic evolution of the Gamburtsev Subglacial Mountains buried below more than 3 km of ice. The multi-year multi-parameter IceBridge project involves using an AIRGrav system during flights over the Antarctic with a NASA DC-8, and Greenland and the Arctic with a NASA DC-8 and P-3, in the spring season of each hemisphere. During the 2009 Antarctica phase, the DC-8 was flown from 500 m to 11000 m altitude at 300 knots, covering up to 9,000 km per flight in 12 hour flights, with differential GPS baselines as long as 3,000 km. The airborne gravity data is being used to constrain the water depth of subglacial cavities beneath several floating glaciers and ice shelves to support realistic computer modeling of ocean circulation beneath the ice shelves. Case Study #5 – Marine AIRGrav. The AIRGrav system was installed on the deck of a 17 m dive boat in Kingston, Ontario. A survey was performed over two days in Lake Ontario to test the performance of the AIRGrav system on a seaborne project in a moderately high sea state with 2 m wave height. A total of 470 km of line data was acquired in a grid pattern with 200 m line spacing. The resultant gravity grid has an accuracy of 0.12 mGal and a resolution of 300 m.

1B08.6 ID:3894 **12:15**

A new interpolation method for airborne geophysics

Qingmou Li , *Sonya Dehler*
GSC Atlantic, NRCan

Contact: qingmou.li@nrcan.gc.ca

Abstract: Generating a grid from airborne geophysical measurements is the starting point for not only post data processing but also their visualization and overlaying with other data sources in a GIS environment. Interpolation methods must deal with the problem that line-based airborne geophysical measurements have sample spacing along flight lines that is much higher than spacing between lines. The line-based measurements are often gridded to accommodate the lower line resolution, and much of the higher resolution is not captured in the gridding process. In this approach, a new method is presented that was specifically developed for solving this problem. It is based on singular value decomposition (SVD), spatial PCA, and uses their intrinsic relationship. It is designed to keep the high resolution information along lines, with most respect to known points (measurements), in contrast to other methods that only keep the across line lower resolution by smoothing out along line high resolution information. The new method is tested and compared with other methods with extracted flight lines with different line gaps within an existing airborne magnetic grid from the east coast of Canada. The test results show that the new interpolation method has advantages in retaining high resolution along flight lines, and gives a better match to existing measurements and map details in comparison with the Inverse Distance Weighting (IDW), Spline, and Kriging methods, specifically when the flight line gaps are large. The implemented algorithm of this new method is fast and can be executed in real time. Key Words: Interpolation; Airborne geophysics; SVD; spatial PCA; Line based measurement *Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, NS, Canada, B2Y 4A2, qli@NrCan.gc.ca sdhler@NRcan.gc.ca

Ocean Climate Change, Variability and Impacts (Part 1) / Changements et variabilité du climat océanique et leurs effets (Partie 1)

Room / Endroit (Panorama), Chair / Président (John Loder), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B09.1 ID:3663 INVITED/INVITÉ 11:00

News of the Northeast Pacific Ocean

W.r. Crawford

Fisheries and Oceans Canada
Contact: bill.crawford@dfo-mpo.gc.ca

Ocean temperatures and marine life in Canadian waters of the northeast Pacific Ocean respond quickly to changes in seasonal winds. Seasonal winds in turn are sensitive to El Niño and La Niña events. These changes have been noted over the past decade in the annual State of the Ocean Reports prepared by members of the Fisheries and Oceanography Working Group in Pacific region. An especially sudden shift in winds and ocean temperature took place in early 2010 as the winter storms of the northeast Pacific Ocean responded to the 2009-2010 El Niño. I will show details of how the ocean and its marine life responded to the 2010 event, and how response of marine life to ENSO events might change with climate warming.

1B09.2 ID:3302 11:30

Toward a Regional Climate Model for the British Columbia Continental Shelf

Michael Foreman [1], *Badal Pal* [2], *Bill Merryfield* [2], *Diane Masson* [1], *John Morrison* [1]

[1] Institute of Ocean Sciences, DFO
[2] Canadian Centre for Climate Modelling and Analysis, EC
Contact: mike.foreman@dfo-mpo.gc.ca

Though statistical downscaling has been widely used to interpolate results from global climate models to specific oceanic locations, the resultant fields can be inaccurate if those models are unable to represent important meso-scale features and processes. This is certainly the case for the waters off British Columbia where mountainous terrain and complicated coastlines and bathymetry combine with seasonally varying winds to produce sub-regions that have high biological productivity in the summer and that export larvae and nutrients offshore in the winter. In order to better understand how these processes may change in the future, a regional climate model is being developed for the continental shelf waters off British Columbia. This model will initially take its atmospheric forcing from one or more regional, atmosphere-only, climate models (either the Canadian Regional Climate Model or the University of Washington regional climate model) and have its coastal freshwater discharges estimated from downscaled precipitation and watershed models. Initial and lateral boundary conditions for salinity and temperature will be computed as downscaled anomalies from global models. In this presentation, we will describe progress in the development of this model with particular attention given to analyses of the winds that will be used to force it.

1B09.3 ID:4048 11:45

Dynamical downscaling simulation over the Gulf of the St. Lawrence and

Northwest Atlantic using CRCM

Lanli Guo , *Will Perrie* , *Zhenxia Long*
Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

We use CRCM to dynamically downscale outputs from CGCM3 for the North Atlantic Ocean, Gulf of St. Lawrence and related coastal areas. There are several challenges for driving the regional climate model by directly using CGCM3's outputs as initial and boundary data, over the coastline areas. Compared with the NARR data, the simulated 2m air temperature in CRCM is colder in summer time and warmer in winter time, reflecting CGCM3 characteristics. Comparisons with in situ station data suggests the CRCM winds are biased low, in some ocean areas of this domain, particularly in the summer time. These results reflect the fact that CRCM uses CGCM3's coarse resolution sea surface temperature; another reason is a low bias in the drag coefficient, for example over the Gulf of St. Lawrence and the coastline area of the domain. To solve these problems, we use NARR's sea surface temperature climatology to replace CGCM3's sea surface climatology and we adjust the minimum drag coefficient accordingly in the new simulation. Our final results show that these modifications significantly improve the CRCM simulation. Compared with the NARR data, we can find that CRCM can reasonably simulate the seasonal 2m air temperature, 10m wind and other surface fields over St. Lawrence and related coastline areas. The resulting simulated seasonal evolutions of 2m air temperature and 10m wind are much closer to the observational data than previous simulations.

1B09.4 ID:3314 12:00

The link between variations in sea surface height and circulation in the North Atlantic

Zeliang Wang [1], *Youyu Lu* [1], *Daniel Wright* [1], *Frederic Dupont* [2], *Charles Hannah* [1]

[1] Bedford Institute of Oceanography
[2] Environment Canada
Contact: wangz@mar.dfo-mpo.gc.ca

A coarse-resolution global ocean model is used to study inter-annual to decadal variations in the North Atlantic. Comparisons with altimeter, tide gauge and hydrographic observations show that the model possesses considerable skill in simulating the large-scale changes in sea surface height (SSH). Interannual to decadal variations in SSH are represented by the 1st EOF mode . The variability in the 1st mode principal component (PC1) correlates well with transport variations, particularly with PC2 of the depth-integrated streamfunction, the subtropical gyre transport carried in the upper 1000 m and the transport carried over the full water depth in the subpolar gyre. There is very little correlation with variations in the transport carried below 1000 m in the subtropical gyre. Variations of the subtropical gyre are shown to be mainly wind driven whereas

both heat and wind forcing are important in driving the variations in the strength of the subpolar gyre.

1B09.5 ID:3466 12:15

Impact of Greenland melt on the sub-polar North Atlantic through different resolution models

Véronique Lago , *Paul G. Myers*
Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada
Contact: lago@ualberta.ca

The Greenland ice cap is the largest freshwater reservoir in the Northern Hemisphere. In the past, it was assumed that the ice cap was in an approximate steady state, gaining the same amount of mass at high altitudes that it lost to runoff and calving. Recent observations as well as climate change predictions suggest that the ice cap is now in a mass deficit situation, providing additional freshwater to the subpolar North Atlantic. Since the subpolar gyre is a site of deep water formation, which is sensitive to freshwater addition, understanding the impact of this runoff from Greenland is important. A few studies have examined this potentially significant climatic impact, but have done so in fairly coarse resolution models (1 degree and coarser). Since the processes that impact freshwater transport in the ocean are often small scale, especially in the area of the subpolar gyre, we believe that the results on the impact of the freshwater discharge from Greenland may be resolution dependent. Thus, we examine the sensitivity of ocean models to this Greenland runoff in a suite of model simulations using the NEMO ocean/sea-ice modelling system. We use resolutions ranging from 2 degree to 1/4 degree. The location and seasonality of the discharge is also considered in a series of idealized sensitivity experiments.

Oceanography General Session / Séance générale sur l'océanographie

Room / Endroit (Pinnacle), Chair / Président (Guoqi Han), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B10.1 ID:4032 11:00

Rossby Wave Variability along 38N in the North Atlantic

Paul Myers , *Ji Lei* , *Andrew Bush*
Department of Earth and Atmospheric Sciences, University of Alberta
Contact: pmyers@ualberta.ca

Variability of North Atlantic water masses along 38N is examined based on data in the International Council for the Exploration of the Sea (ICES) hydrographic database. Data is extracted from 1908 to 2004, but the main focus is on variability post 1950. An objective analysis approach in an isopycnal framework is used to project data onto 38N, using a longitudinal resolution of 1/3 degree and the 50 isopycnal layers of variable thickness. Long term mean temperature and salinity fields are produced, as well as overlapping 3 year-running mean analyses (from 1950 to 2004). Extensive multi-decadal variability is observed, in both shallow and deep layers. The phase of the variability is different between layers, and also changes as one moves west to east across the basin. Important water masses showing significant variability include those of the Deep Western Boundary Current (DWBC) and the Mediterranean Water. Distinct core of Labrador Sea Water can be seen either side of the mid-Atlantic Ridge, well away from the DWBC. Baroclinic rossby wave progagation is observed in intermediate layers. Further analysis shows that the rossby wave speed is dependent on the details of the high resolution stratification produced by the analysis. The long term mean phase speeds are also sensitive to whether they are computed using climatological data fields, or averaged from computations based on annually varying data fields.

1B10.2 ID:3809 11:15

Composition/conductivity/density relationships in anomalous (otherwise known as real) seawaters

Rich Pawlowicz
University of British Columbia
Contact: rich@eos.ubc.ca

It is well known that the relative composition of seawater is almost but not quite constant. In practise, the effects of the (small) anomalies from the composition of so-called Standard Seawater have been almost universally ignored in routine estimation of salinities, and densities from salinities, for almost a century. Here I describe a theoretical model that relates seawater composition, conductivity, and density. A numerical implementation of the model can be used to predict density anomalies resulting from observed conductivities, carbonate-system parameters, and nutrient concentrations. Results replicate direct observations of density anomalies in both laboratory experiments and in the open ocean. Theoretical analysis suggests that a hierarchy of salinity variables are required to fully describe the effects of anomalous seawater, but numerical experimentation shows that simple conversion factors can be used to relate them all in typical open-ocean situations. These results may be useful in future attempts to understand and model global ocean circulation.

1B10.3 ID:3698 11:30

A Model Study of the Connectivity of Circulation Variations in the Intra-Americas Sea

Yuehua Lin [1], *Jinyu Sheng* [1], *Richard Greatbatch* [2]
[1] Dalhousie University
[2] Leibniz Institut für Meereswissenschaften an der Universität Kiel, Germany
Contact: Yuehua.Lin@phys.ocean.dal.ca

A three-dimensional, data-assimilative, ocean circulation model is used in simulating circulation, hydrography and associated variability in the Intra-Americas Sea (IAS). The model domain covers the region between 8.0˚N and 30.3˚N and 99.0˚W and 54.0˚W, with a horizontal resolution of 1/6˚. The model is driven by 6 hourly wind fields produced by the National Centers for Environmental Prediction (NCEP) and 5-day boundary forcing extracted from reanalysis data produced by the British Atmospheric Data Centre (BADC). The model is integrated for 4 years from 1999 to 2002. The model performance is assessed by comparing model results with observational transport estimates for the Yucatan Current (from the Canek data) and the Florida Current (from the cable data). The overall features of the model-calculated circulation and variability are in good agreement with the observations. The later 3-year model results are used to study circulation and variability in the IAS at high frequency (timescales less than 20 days), intermediate frequency (between 20 and 120 days), and low frequency (greater than 120 days) separately. Based on numerical experiments, high frequency circulation variations are associated with strongly wind forcing and flows through open boundaries. Caribbean eddies play an important role on the connectivity between the Gulf of Mexico and the Caribbean Sea at both intermediate and low frequencies. Circulation variability at low frequencies is mainly correlated with variations of the Loop Current system.

1B10.4 ID:3909 11:45

Impact of atmospheric forcing on model simulations of the Northwest Atlantic Ocean

Ying Zhang , *Entcho Demirov*
Department of Physics and Physical Oceanography, Memorial Univeristy of Newfoundland
Contact: jszhu@mun.ca

Some previous observational studies demonstrated that relatively small-scale patterns in the atmospheric fields related to the Greenland tip jets may play an important role in the sub-polar ocean dynamics and winter convection. These patterns are relatively weak in the NCEP/NCAR reanalysis due to the relatively coarse spatial resolution. The talk will present the results from a study of the impact of surface atmospheric forcing resolution on model simulations of the general circulation over the Northwest Atlantic. The ocean model is NEMO/LIM coupled sea-ice model. The NCEP/NCAR reanalysis is downscaled by using a high-resolution atmospheric regional model (WRF) over the Northwest Atlantic Ocean. The two ocean model solutions forced by NCEP/NCAR reanalysis and WRF-derived fields are compared and the differences between them are discussed.

1B10.5 ID:3507 **12:00**

The vertical structure of the global baroclinic tidal currents: Assessing the skill of 1/12 degree global HYCOM

Patrick Timko [1], *Brian Arbic* [2], *Robert Scott* [3]
[1] Center for Ocean-Atmospheric Prediction Studies, FSU
[2] Center for Ocean-Atmospheric Prediction Studies/Dept. of Oceanography, FSU
[3] National Oceanographic Centre Southampton
Contact: ptimko@coaps.fsu.edu

Tidal forcing plays an important role in many aspects of oceanography. Mixing, transport of particulates and internal wave generation are just three examples of local phenomena that may depend on the strength of local tidal currents. Advances in satellite altimetry have made an assessment of the global barotropic tide possible. However, the vertical structure of the tide may only be observed by deployment of instruments throughout the water column. Typically these observations are conducted at pre-determined depths based upon the interest of the observer. The high cost of such observations often limits both the number and the length of the observations resulting in a limit to our knowledge of the vertical structure of tidal currents. One way to expand our insight into the baroclinic structure of the ocean is through the use of numerical models.

We compare the vertical structure of the global baroclinic tidal velocities in 1/12 degree HYCOM (HYbrid Coordinate Ocean Model) to a global database of current meter records. The model output is a subset of a 5 year global simulation that resolves the eddying general circulation, barotropic tides and baroclinic tides using 32 vertical layers. The density structure within the simulation is both vertically and horizontally non-uniform. In addition to buoyancy forcing the model is forced by astronomical tides and winds. We estimate the dominant semi-diurnal (M2), and diurnal (K1) tidal constituents of the model data using classical harmonic analysis. In regions where current meter record coverage is adequate, the model skill in replicating the vertical structure of the dominant diurnal and semi-diurnal tidal currents is assessed based upon the strength, orientation and phase of the tidal ellipses. The skill assessment provides an estimate the uncertainty when calculating the global baroclinic tidal energy from the model.

1B10.6 ID:3565 **12:15**

The Effect of Statistical Abyssal Hill Roughness on the Generation of Internal Waves

Patrick Timko [1], *Brian Arbic* [2], *John Goff* [3]
[1] Center for Ocean-Atmospheric Prediction Studies, FSU
[2] Center for Ocean-Atmospheric Prediction Studies/Dept. of Oceanography, FSU
[3] Institute for Geophysics, University of Texas
Contact: ptimko@coaps.fsu.edu

Internal waves play an important role in the dynamics and mixing of the ocean interior. It is known that internal waves may be generated by flow over an uneven

bottom. On a regional scale, accurate knowledge of the true ocean bathymetry may be available or may measured directly. On a basin scale or global scale, our knowledge of the true ocean bathymetry is limited. Advances in computing architecture now permit the horizontal resolution of basin scale and global ocean models to exceed our knowledge of the true ocean bathymetry. With limited data, interpolation of available data produces a smoother ocean floor than what we may reasonably expect.

One possible solution is to generate an empirical sea-floor roughness based upon sediment thickness, sea floor spreading rates and direction to simulate expected abyssal hill structure on the ocean floor. The sea-floor roughness generated in such a manner produces an abyssal hill structure with a characteristic horizontal length scale of 2-10 km and characteristic heights 100-200 m. Using a 1/12 and 1/25 degree global ocean model (HYCOM) we investigate the effect of adding empirically derived abyssal hills to the sea floor on the generation of internal waves produced by tidal forcing. At 1/12 degree the horizontal resolution of the model is at the upper end of the abyssal hill length scale but does produce an increase in internal wave activity. We also investigate the effect of increasing the horizontal resolution to 1/25 degree to better resolve the abyssal hill structure.

Mantle Processes and Structure / Processus et structure du manteau

Room / Endroit (York), Chair / Président (Julian Lowman), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B12.1 ID:3447 INVITED/INVITÉ 11:00

Seismic Imaging of the Mantle: Past, Present and Future

Qinya Liu
University of Toronto
Contact: liuqy@physics.utoronto.ca

Seismic Tomography has been a vital tool in probing the Earth's interior and enhancing our knowledge of the dynamical processes in the Earth's mantle. We now have very good understanding of the mantle structure at very long wavelength scale, including slow anomalies associated with mid-ocean ridges, remnants of cold subducted lithosphere in the upper mantle, transition zone, and sometimes extending to the lower mantle, as well as anomalous slow upper wellings rising from the CMB, both in the Central Pacific and Southern Africa region. Ray-based seismic methods have also proved to be extremely useful in

providing localized structural information with the discovery of Ultra-low velocity zone (ULVZ). We review the traditional seismic imaging techniques for the Earth' mantle, both their strengths and weaknesses, and how the seismic images produced from these techniques may be interpreted from a geodynamical point of view. We also introduce the recently popular interface imaging techniques based on Generalized Radon Transform (GRT), applied to both the CMB boundary region and the transition zone. We then end by speculating on promising techniques for both global and localized mantle imaging based on numerical simulations of seismic wave propagation.

1B12.2 ID:4030 **11:30**

The influence of continental thermal properties on mantle flow

Philip Heron , *Julian Lowman*
University of Toronto
Contact: lowman@utsc.utoronto.ca

Continental insulation during the Mesozoic may have made the mantle below former sites of continental aggregation hotter than normal. Previous studies have shown that the formation of a supercontinent over a mantle downwelling can initiate a reorganization of mantle convection planform that results in subcontinental warming. The presence of a mechanical boundary condition characterized by a rigid non-subducting (continental) plate, surrounded by oceanic material allowed to recycle through the mantle, leads to mantle flow reversals and the formation of subcontinental mantle plumes once the continental plate exceeds a critical size.These flow reversals have been argued to result from the mechanical insulation properties of a large continental plate rather than the thermal properties. We investigate the role of continental plate insulation in order to assess the importance of continental thermal properties versus the simple relocation of subduction zones (the influence of the mechanical boundary condition). We investigate convection at high Rayleigh number in 2D and 3D calculations and distinguish continental lithosphere from oceanic lithosphere by specifying distinct thermal insulting properties. We discuss the importance of the thermal properties of continents in heating the mantle on the time-scale of supercontinent aggregation. In all calculations, rigid oceanic plates are featured over the entire non-continental region, allowing us to compare heating under large oceanic plates as well as supercontinents.In a suite of calculations we model the formation of a supercontinent, and investigate the importance of continental thermal insulation by systematically varying the continental thermal properties from a totally insulating layer (no heat flux at the surface), to cases where continents have the same thermal properties as oceanic plates.

1B12.3 ID:3391 **11:45**

Statistical analysis of terrestrial and planetary volcanoes

Laura Sanchez , *Kirk Scanlan* , *Robert Shcherbakov*
University of Western Ontario

Contact: lsanche@uwo.ca

Volcanism is an important mechanism by which internal heat is transported to the surface of the Earth and planets. Volcanoes are therefore the manifestation of a planet's past and present dynamic activity. The goal of this study is to better understand the physical processes governing volcano formation in the solar system. Calderas are present on Earth, Mars, Venus and Io. We examine the statistical distribution of caldera diameters on these four planetary bodies. We find that all the probability densities can be described as a universal distribution if the axes are rescaled using the mean caldera diameter of each planet. By also studying the temporal behavior of eruptions, we want to better understand the general temporal structure of volcanic events on the Earth. The interval between successive volcanic eruptions on Earth, or interocurrence time is an important dynamical characteristic of volcanoes. Here, we look at the interoccurence time between eruptions of Etna, Merapi, Piton de la Fournaise, Cameroon, Heard, Karthla, Mauna Loa and Kilauea volcanoes as well as for the global eruption catalog. As for the distributions of diameters, we observe a collapse of all the data when the axes are rescaled using the rate of eruption for each volcano. These two scaling phenomena reveal self- similarity in the processes governing caldera formation and volcanic eruption. The rescaled interoccurence time probability density functions exhibit a power-law behavior for several orders of magnitudes. This type of behavior is a consequence of the scale-invariant nature of volcanism. The phenomenon triggering volcanic eruptions operates in the same fashion for all volcanoes, which emphasizes the importance of studying volcanism as a global process.

1B12.4 ID:3585 12:00

Investigating the influence of plate boundary motion on mantle thermal evolution using numerical convection models

Julian Lowman [1], *Claudia Stein* [2], *Scott King* [3], *Sean Trim* [1]
[1] University of Toronto, Canada
[2] University of Muenster, Germany
[3] Virginia Polytecnic Institute and State University, USA
Contact: lowman@utsc.utoronto.ca

A number of studies examining the influence of plates on mantle convection have concluded that planform and temperature are strongly influenced by the plate geometry (i.e., plate boundary locations). However, the small number of studies that have modelled evolving plate geometries over substantial periods (greater than a mantle transit time) indicate that mantle planform may not correlate so well with plate geometry when plate boundaries are able to evolve. Indeed, conceptual models such as a fixed hotspot reference frame of mantle-plume origin require a certain degree of decoupling of the location of deep mantle thermal features from the motion and geometry of the plates. In order to properly assess the influence of plate-like surface motion on mantle convection, we investigate 3D plane-layer convecting systems featuring plates with boundaries

that move at comparable speeds to the velocities associated with convection driven flow in the mantle. Plate velocities in our calculations are time-dependent and use a force-balance method to ensure that the plate motion neither drives nor resists the convection. We compare the evolution of the surface and basal heat flow and changes in convection planform in calculations in which simple plate geometries change with time while plate velocity responds dynamically to the evolving driving forces in the plate-mantle system. The numerical model features polygon-shaped plates resulting in a surface characterized by piece-wise continuous uniform velocities corresponding to each plate interior. We compare cases where plate boundaries are held fixed with cases where the plate boundaries evolve dynamically in response to motion of the plate triple junctions. In addition to thermal evolution we examine the time-dependence of the plate velocities in these models. The influence of the plate boundary motion on convection in the deep mantle is compared in models featuring different heating modes.

1B12.5 ID:3397 **12:15**

Receiver function analysis of crustal and upper mantle stratigraphy across the western Superior Province

Morounkeji Olaleye , *Andrew Frederiksen*
University of Manitoba
Contact: frederik@cc.umanitoba.ca

The Superior Province is the Earth's largest Archean craton. Its represents the nucleus of the North American continent, originating from widespread crustal accretion at about 2.6 Ga. The western Superior has a lineated structure; its strong east-west tectonic fabric is most commonly attributed to the formation and accretion of island arcs and accretionary prisms. We are examining the stratigraphy, velocity structure and thickness of the crust and upper mantle beneath the western Superior Province of the Canadian Shield, through the analysis of seismic discontinuities on the radial and transverse components of P-wave receiver functions. The data used are from POLARIS/FedNor and CNSN earthquake-recording stations across western Ontario, using events from 2003 to 2008. Receiver functions were calculated using a panel deconvolution approach (using inter-trace regularization constraints) to improve the signal-to-noise ratio. The receiver function data show indications of crustal and mantle layering. Stations east of the Nipigon embayment reveal a complicated and layered mantle, whereas west of the embayment reveals a more uniform mantle. These observations agree well with results from recent shear wave splitting studies, which indicate strong splits to the west but weaker, less coherent splits to the east. Other observations to date include: crustal discontinuities which lose continuity laterally, possibly due to subducting structures and/or regions of velocity gradients, and lobes of opposite polarities on the radial and transverse components of the receiver functions, which are indicative of seismic anisotropy or dipping features. Modelling of these data for dip and anisotropy is in progress. The results obtained from this study will be integrated with previous receiver

function studies, tomographic models, and LITHOPROBE reflection and refraction surveys across the western Superior, and compared to tectonic theories of continental root formation due to imbrication of subducted Archean material, underplating, and accretion of island arcs in that region.

Geoid-based North American Vertical Datum / Référentiel altimétrique nord-américain fondé sur le géoïde

Room / Endroit (Laurentian), Chair / Président (Marc Veronneau), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B13.1 ID:3582 **11:00**

Discussion on the North American Vertical Reference System (NAVRS)

Marc Veronneau
Natural Resources Canada
Contact: marcv@nrcan.gc.ca

Canada has been using the same vertical datum for the last 75 years or so. The Canadian Geodetic Vertical Datum 1928 (CGVD28) was realized in 1928 and officially adopted by Canada in 1935. Today, this vertical datum, made of some 70,000 benchmarks along major roads and railways mainly in southern Canada, does not provide the proper national coverage; includes significant distortions at the national scale; and is slowly disappearing (benchmarks) due to the inefficiency and high cost of maintaining such a network by levelling methods.

A Height Modernization project is presently in progress in Canada. This initiative started in 2002 will see the adoption of a geoid model as the realization of the new vertical datum for Canada. The current time frame is to introduce the new vertical datum in 2013. In the meantime, the US National Geodetic Survey (NGS) is also moving towards a geoid-based vertical datum, but with an adoption date around 2018. The Geodetic Survey Division and NGS are already in discussion on how to define and maintain this new datum to assure consistence and coherence across North America and to tie it properly to a global vertical reference system.

The paper will define and discuss the fundamental components that form the basis of a modern vertical reference system and present the current options and challenges in defining and maintaining the North American vertical datum. It will investigate advantages and disadvantages for each option in terms of long-term consistency and needs in determining heights. The time dimension of vertical datum will be included to address the dynamic nature of the geoid and topography and future requirements in association with climate changes and water resource management.

1B13.2 ID:3817 **11:15**

Towards a Geoid-based Height System in the Great Lakes Region

Elmas S. Ince [1], *Michael G. Sideris* [1], *Jiangliang Huang* [2], *Marc Véronneau* [2]
(Presented by *Elmas Ince*)
[1] University of Calgary
[2] Geodetic Survey Division, NRcan
Contact: eince@ucalgary.ca

Definition of a height system is essential when dealing with the development of a vertical reference datum. Especially for vast countries like Canada and USA, the definition may need to be revised and developed for a new datum to consider the changes such as vertical land motion, the recent acquired data sets, the aimed accuracy and new technologies. Evidently, the methods used to obtain the vertical datum need to be developed for the desired deliverables. Spirit levelling, the method which has been known the most accurate and widely used can no longer meet the requirements of recent space-based global positioning technologies such as GPS. Instead, the idea of a gravimetric geoid model as a vertical datum has emerged as a reflection of the recent requirements for the height determination. In North America, the Great Lakes and the St. Lawrence River region is one of the most challenging and compelling parts regarding the definition, development, and evaluation of the new geoid model, which is aimed to be of 1 cm accuracy. For the development and implementation of the new vertical datum in this area located on the border of Canada and USA, the most recent different data sets including satellite and terrestrial gravity, topography, and bathymetry data, have to be combined properly to make an improvement to the existing models, and to satisfy the requirements of vertical reference datum for a long term. This study is part of the project that aims to determine a geoid-based vertical reference datum surface for the Great Lakes and the St. Lawrence River region. The discussion on the different height systems definitions, the comparison and analysis of the existing geoid models (EGM2008, NGS Geoid Model 2009, CGG2000, CGG2005 and the recent GSD's experimental models) and the strategy for improving the geoid model in terms of the intended accuracy will be presented.

1B13.3 ID:3761 **11:30**

Updating the International Great Lakes Datum of 1985

Daniel Roman , *Yan Wang* , *Xiaopeng Li* , *Jarir Saleh*
NOAA's National Geodetic Survey
Contact: dan.roman@noaa.gov

The International Great Lakes Datum of 1985 (IGLD85) was implemented using the geopotential numbers determined as a part of the North American Vertical Datum of 1988 (NAVD 88). NAVD 88 was a joint project of the United States and Canada to develop a common regional height system based on Helmert orthometric heights determined from an adjustment of geopotential numbers. NAVD 88 was never adopted in Canada due to suspicion of overly large systematic errors that subsequent studies have borne out. IGLD85 replaced IGLD55 and, thus, a replacement would seem due in 2015. Collaboration has already begun for this between the United States and Canada under the auspices of the International Great Lakes Commission. This effort to update IGLD85 must be tied into the development of a regional geoid height model for all of North America. A common regional geoid height model would be combined with ellipsoidal heights in an updated reference frame to determine orthometric heights in a renewed effort to develop a common regional height system. This presentation will focus on potential mechanisms for using the geoid height model to also determine dynamic heights and a potential IGLD15.

1B13.4 ID:4071 11:45

Testing Stokes Integration Using Global Geopotential Models

Robert Kingdon , *Petr Vaníek* , *Marcelo Santos*
University of New Brunswick
Contact: robert.kingdon@unb.ca

A key process of Stokes-Helmert geoid modelling is the conversion of downward continued gravity anomalies to cogeoid heights through Stokes integration. This process can be tested by comparing results computed using e.g. different Stokes integration radii, or different modification degrees if a modified kernel is used. When the results from these different computations are different, it can be the result of a problem with the Stokes integration itself, or with the input values of gravity anomalies on the geoid resulting from previous calculations. Instead of using input gravity anomalies that depend on other calculations, we propose testing Stokes integration using a grid of input gravity anomalies determined from the same geopotential model used for the far zone component of Stokes integration. Furthermore, we evaluate the far zone contribution using the geopotential model to the same degree as for the near zone contribution. Differences between Stokes integration results using different parameters in this case can only be the result of the discretization error, or some problem with the Stokes integration routine. In other words, this test of Stokes integration excludes contamination from other parts of the geoid computation process. We present numerical results of such a test for the Stokes integration procedure from UNB's SHGeo package, and show that applying this test, the RMS of the differences between results with integration radii of 2º and 6º, and modification/reference field degrees of 20 or 60, is never larger than 7mm.

1B13.5 ID:3641 12:00

Methods of Using the Satellite-Based Global Gravity Models to Model the Geoid in Canada

Jianliang Huang , *Marc Veronneau*
Geodetic Survey Division, CCRS, Natural Resources Canada
Contact: jianhuan@nrcan.gc.ca

The remove-restore method is a standard approach to combine a global spherical harmonic gravity model and terrestrial gravity data for the determination of regional geoid models by Stokes' integral. Ideally, the global model would be a satellite-only solution and the terrestrial data are those collected on or near the Earth's surface. In this approach, the satellite model defines the long-wavelength geoid components while the terrestrial data complements it with finer details. It has been shown that the latter is often biased with respect to the satellite model primarily due to its inhomogeneous distribution, datum errors and various geodynamic processes. Thus a proper combination between them is generally required to determine an unbiased, precise and high-resolution regional geoid model.

The combination is achieved through the Stokes kernel modification. Most existing modification methods were proposed before the CHAMP and GRACE missions. Satellite gravity models were then less-accurately determined and limited to low spatial resolution. Therefore one key objective of the kernel modifications was to minimize the far-zone contribution (or the spatial truncation error) of Stokes' integral which was largely determined by the satellite gravity models. These modifications often retain a significant part of the biases in the terrestrial gravity data when effectively reducing the far-zone contribution. The satellite models from CHAMP, GRACE and GOCE call for the assessment and revision of existing modification methods and the development of new kernel modification methods.

In this work, two types (deterministic and stochastic) of the degree-banded (or band-limited) modification methods are applied to combine the new satellite models with the terrestrial gravity data to improve regional geoid models. Then, they are compared with the existing methods in terms of the total geoid error, including both random errors and biases. Finally, they are used to determine geoid models in Canada using the GRACE gravity model.

1B13.6 ID:3680 12:15

Absolute gravity operations & priorities within Natural Resources Canada

Joseph Henton , *Jacques Liard* , *Anthony Lambert* , *Nicholas Courtier* , *Michael Schmidt* , *Jason Silliker* , *Marc Véronneau*
Natural Resources Canada
Contact: jhenton@NRCan.gc.ca

Absolute gravity (AG) provides high-precision and high-accuracy measurements of the acceleration due to gravity at the Earth’s surface. Repeated measurements at the same location record changes in gravitational acceleration due to a combination of vertical movement of the Earth's surface and subsurface mass movement. Within Natural Resources Canada (NRCan) there are two absolute gravity facilities. The Geodetic Survey Division (GSD) operates FG5-236 from its AG facility at the Canadian Absolute Gravity Site in Cantley, Québec (near Ottawa, Ontario). The primary role of GSD is to maintain, continuously improve, and facilitate efficient access to the Canadian Spatial Reference System (CSRS). The CSRS has a national-scale focus with AG operations providing, primarily: datum definition for relative gravity surveys; support for monitoring the time evolution of vertical component of geometric RF; and support for the maintenance of a new gravity-based/geoid height reference system. AG efforts at GSD are also increasingly being designed to provide downstream support to scientific priorities within NRCan. The Geological Survey of Canada's (GSC) Canadian Crustal Deformation Service operates FG5-106 from its absolute gravity facility at the Pacific Geoscience Centre (near Sidney, BC). The GSC focuses absolute gravity efforts in two primary regions: Vancouver Island surveys and a mid-North American continent profile. The primary motivation for repeated Vancouver Island AG surveys is to support earthquake hazards studies by providing a better understanding of Cascadia Subduction Zone dynamics. The main rationale for annual mid-continent AG surveys is monitoring water resources in the Prairies (in collaboration with GRACE data products) as well as post-glacial isostatic adjustment studies. Finally, AG data collected by these two Canadian facilities may also prove highly relevant to the development of collaborative efforts with the U.S. National Geodetic Survey and other interested North American participants wishing to monitor the time evolution of the geoid model over North America.

Drought, Climate and Society (Part 1) / Sécheresse, climat et société (Partie 1)

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Ron Stewart), Date (01/06/2010), Time / Heure (11:00 - 12:30)

1B14.1 ID:3360 **11:00**

The Drought Research Initiative: What Has Been Accomplished

Ronald Stewart [1], *John Pomeroy* [2], *Richard Lawford* [1]
[1] University of Manitoba
[2] University of Saskatchewan
Contact: ronald_stewart@umanitoba.ca

The Canadian Prairies are often subjected to drought and it is sometimes catastrophic. A recent event occurred over the period 1999-2005 and it produced some of the driest conditions over the historical record. To address such droughts, a research network DRI (Drought Research Initiative) was established. The particular focus of DRI is to better understand the factors that led to, sustained and ended this recent drought including its internal structure and to contribute to the better prediction of such events. To accomplish this objective, the drought has been considered from several perspectives involving the atmosphere, surface and sub-surface and it also included the role of vegetation. This drought was unusual in that its large scale forcing was quite variable over its duration, regions of record high precipitation sometimes occurred simultaneously across the Prairies, and cloud fields were common. It nonetheless produced some of the greatest reductions in sub-surface moisture on record and it led to major declines in river flows. The DRI research community from across the country is furthermore working closely with many partners affected by the drought so that they can better cope with such events in the future. As DRI approaches its conclusion, this presentation summarizes what DRI has accomplished and what remains to be addressed in regards to drought over the Prairies and other regions of Canada.

1B14.2 ID:3785 11:15

Towards a comprehensive-data driven depiction of drought over the Canadian Prairies

Phillip Harder [1], *Patrice Constanza* [2], *Ronald Stewart* [1], *Richard Lawford* [1]
[1] University of Manitoba
[2] McGill University
Contact: harderp@cc.umanitoba.ca

Drought is a complex phenomenon with serious societal implications. In addition to precipitation, other important components of this extreme relate to the atmospheric, surface, sub-surface and biological domains and are integral to a thorough understanding of drought. Many of the datasets describing these domains, essential to drought research, are produced in traditionally unrelated disciplines and often in isolation. To facilitate its research program a major effort has been undertaken within the Drought Research Initiative (DRI) to address this issue by centralizing the collection and identification of many of the datasets necessary to properly characterize drought. By utilizing the capabilities of emerging freeware geospatial technologies, such as Google Earth, DRI has additionally developed integrated visualizations that add another dimension beyond the traditional means of characterizing drought. Experiences and outcomes of DRI's effort will be discussed in regards to the development, in terms of data, of a comprehensive depiction of drought over the Canadian Prairies.

1B14.3 ID:3646 11:30

Historical perspective and meteorological diagnosis of the 1999-2005

Canadian Prairie drought

Lisa Hryciw , *John Gyakum* , *Eyad Atallah*
Department of Atmospheric and Oceanic Sciences, McGill University
Contact: lisa.hryciw@gmail.com

The Canadian Prairies are susceptible to droughts, which are among the most costly natural disasters in Canada in terms of socio-economic impact. The recent 1999-2005 Canadian Prairie drought, which resulted in a loss of approximately $4-5 billion, is historically unique in that it does not conform to previously established atmospheric circulation patterns (Pacific/North American (PNA) teleconnection pattern) typically associated with Prairie drought. It is determined that there are several distinct mechanisms, or a succession of individual events, which are the cause of the synoptic-scale subsidence leading to this prolonged period of drought conditions. In addition, the meteorological severity of the 1999-2005 drought appears to be localized to certain stations such as Saskatoon, rather than having a consistent widespread signal across the Prairies. Precipitation data from several stations in Alberta, Saskatchewan, and Manitoba are analyzed, with a focus on the growing season (May to August). The two driest and wettest 30-day periods in 1999-2005, as determined from the precipitation data, are selected and scrutinized more closely with vertical cross sections of other variables such as relative humidity, temperature, and omega. Synoptic maps are analyzed for these extreme periods to determine the differences in the flow patterns. Vertically integrated moisture divergence is also calculated from both the North American Regional Reanalysis (NARR) and the NCEP-NCAR Global Reanalysis, but inspection shows discrepancies between the reanalyses and ambiguities in terms of identifying the drought. From a historical perspective, there appears to be a disconnect between the socio-economic impacts and the meteorology in this particular drought – the drought being more economically significant than meteorologically significant – shedding light on society's increased vulnerability associated with changing agricultural practices.

1B14.4 ID:3339 11:45

Atmospheric and Oceanic Variability Associated with Growing Season Droughts and Pluvials on the Canadian Prairies

Barrie Bonsal , *Amir Shabbar* , *Kit Szeto*
Environment Canada
Contact: barrie.bonsal@ec.gc.ca

Atmospheric and oceanic variability associated with growing season (May to August) droughts and pluvials over the Canadian Prairies are examined. Using the Palmer Z-Index as a drought indicator, extreme dry and wet seasons are firstly identified for the period 1950 to 2007. Inter-relationships among several atmospheric parameters including large to synoptic-scale circulation patterns, low-level moisture transport, moisture convergence, precipitable water content, and cyclone frequency are then assessed during extreme drought and pluvial

periods. In addition, links to the previous winter's global sea-surface temperature (SST) patterns are identified using the multivariate technique of singular value decomposition. Results show that moisture from the Gulf of Mexico is notably decreased during the identified drought seasons. Stronger than normal subsidence associated with anomalously high pressure over north-western North America also leads to weakened moisture transport from the Pacific Ocean. Conversely, during pluvial seasons, low-level flow aided by the circulation associated with increased cyclone frequency over western North America brings abundant moisture northward into the southern Prairie region. These circulation patterns over western North America and their associated moisture transport anomalies into the Prairies show some linkages to previous winter SST patterns both globally, and in the Pacific Ocean where the SSTs are similar to those associated with inter-annual El Niño/Southern Oscillation (ENSO) events and ENSO-like inter-decadal North Pacific variability. This is the first study to examine several inter-connected atmospheric and oceanic processes at various scales as they relate to the occurrence of growing season extreme climate over the Canadian Prairies. Results provide a better understanding into the physical mechanisms responsible for the initiation of and perpetuation of these extremes.

1B14.5 ID:3827 **12:00**

Water cycling and hydroclimate extremes in the Canadian Prairies

Kit Szeto
Climate Research Division, Environment Canada, Downsview ON Canada
Contact: kit.szeto@ec.gc.ca

The Canadian Prairies is characterized by the frequent occurrence of droughts and pluvials that significantly affect the region's agricultural activities. To better understand the physical processes that affect the development of these hydroclimate extremes in the region, monthly timeseries of surface and atmospheric water budgets were calculated for the 1960-2002 period by using various datasets. Results from contemporaneous correlations among the budget components were interpreted with knowledge of hydroclimate processes that affect the region to clarify the roles of interplays between winter and summer processes, and between regional and larger scale processes, in governing the interannual variability of warm season precipitation. Based on the results of the analysis, we hypothesize that the interannual variability of warm-season precipitation in the Canadian Prairies is largely governed by synoptic activities that occur in its southern vicinity. Extreme drought would develop when both low soil moisture and evapotranspiration caused by low snowfall from the previous winter occur in conjunction with lower than normal frequency of favorable synoptic systems during the warm season whereas extremely wet growing seasons are largely a result of anomalously high occurrence of these systems. The applicability of the hypothesis to account for the occurrence of past pluvials and droughts in the Prairies and also its implications for future Prairie drought research will also be discussed.

1B14.6 ID:4034 12:15

Moisture Variability over Grain Crops and Importance to Convective Environments and Drought

G.s. Strong [1], *C.d. Smith* [2], *Daniel Brown* [1]
(Presented by *Geoff Strong*)
[1] Earth & Atmospheric Sciences, University of Alberta
[2] Environment Canada
Contact: geoff.strong@shaw.ca

Daily evapotranspiration from grain crops is recognized as an important factor in the initiation and life cycle of convective weather systems on the prairies. Moreover, evapotranspiration that reduces significantly or terminates due to low soil moisture prior to crop maturation is a risk signal for the initiation of drought. A fixed transect in the St. Denis SK agricultural region during 1992, with sensors at standard 1.5 m elevation, revealed the average diurnal increase in boundary layer moisture from local evapotranspiration to be 4 g kg-1 mixing ratio. Values were at least 1 g kg-1 higher over a wheat crop than over prairie grass.

Mobile transects of temperature and humidity designed to estimate the urban heat/dry islands across Edmonton during summer 2009, also afforded opportunities to record spot vertical profiles of humidity over grain crops, specifically canola in this instance. At the same time, two instrumented towers at Kenaston SK (south of Saskatoon) provided vertical profiles from 0.5 to 6 m over crop and grass throughout the summer of 2009. Other data collected from this site included eddy correlation estimates of evapotranspiration and soil moisture. These datasets provide horizontal and vertical gradients of temperature and moisture over grain crops and grass to compare with the 1992 St. Denis transects.

The importance of these gradients of temperature and moisture are discussed in terms of their diurnal influence on prairie convective environments, and their seasonal effect on the initiation and cessation of drought in the context of the Drought Research Initiative (DRI).

Interactions Among Biogeochemical Cycles (Part 2) / Interactions entre les cycles biogéochimiques (Partie 2)

Room / Endroit (Ballroom A), Chair / Président (Merrin Macrae), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C01.1 ID:3445 14:00

Biogeochemical and Environmental Controls on Greenhouse Gas Cycling in Riparian Wetland Soils

Richard Bourbonniere [1], *Karen Edmondson* [1], *Merrin Macrae* [2]
[1] Environment Canada, Water Science & Technology Dir.
[2] University of Waterloo, Dept. of Geography & Environmental Mgt.
Contact: rick.bourbon@ec.gc.ca

Positioned between sources of nutrient contamination and potentially sensitive streams, riparian wetlands are known to be zones of high biogeochemical activity, e.g. high C, N & P uptake and turnover, and many studies reveal the ability of riparian wetlands to remove nutrients, particularly nitrate, from runoff thus limiting stream contamination. To better understand the fate of C and N in riparian zones it is useful to study soil gas exchanges and the factors that control their production and emission to the atmosphere. We report on carbon dioxide (CO2) from soil respiration, methane (CH4) and nitrous oxide (N2O) emissions measured during three growing seasons (May-Nov) along seven transects across a riparian wetland in Valens, ON. Four topographic positions are identifiable throughout the wetland: field edge (FE), riparian slope (RS), riparian level (RL) and stream bank (SB). Growing season precipitation was less than the 30-year normals (539 mm) in 2007 (230 mm) and 2009 (419 mm) and greater in 2008 (555 mm). Soil moisture distributes along the riparian zone profile (SB > RL > RS > FE) and tracks with inter-annual differences in precipitation. Cumulative fluxes over the growing season provide an overall view of riparian GHG emissions. Emissions of the three GHGs are strongly influenced by topographic position, and in particular the moisture regimes characteristic of each position. GHG emissions at the RL position are most sensitive to inter-annual moisture such that cumulative CO2 emissions are higher during the drier years while CH4 and N2O are very much higher during the wetter years. Overall scaling of the global warming potential (GWP) according to topographic position showed that suppressed CO2 emission due to increased soil moisture more than compensated for the higher CH4 emissions in wetter years. Thus GWP in drier years is greater than in wetter years.

1C01.2 ID:3864 14:15

Greenhouse gas efflux from Irish headwater lakes

Colin Whitfield , *Julian Aherne* , *Helen Baulch*
Trent University
Contact: cwhitfield@trentu.ca

In catchment-based biogeochemical studies, the loss of C and N from surface waters to the atmosphere is an important but often overlooked component of elemental cycles. In recent years, the efflux of methane (CH4) and carbon dioxide (CO2) from surface waters has received considerable attention. Lakes worldwide are typically supersaturated with these greenhouse gases relative to

the overlying atmosphere, and consequently act as sources. Much less is known about potential fluxes of nitrous oxide (N2O) from freshwater aquatic systems to the atmosphere, and existing emission estimates range considerably. Given climatic and hydrological influences, among others, on elemental cycling patterns, there is a need to better understand the magnitude of gaseous efflux from surface waters. As part of a survey of the response of remote acid-sensitive Irish lakes (n = 126) to atmospheric pollution, trace gas (CO2, CH4, N2O) concentrations were measured alongside a full suite of water chemistry and landscape variables. The study lakes are small and well-mixed, and are predominantly located in high elevation headwater catchments. Measured lake and atmospheric CH4, CO2 and N2O concentrations were used in wind models to estimate gaseous efflux from the lakes. For each gas, a considerable range in efflux potential is exhibited across the lakes. The relationship between efflux rates and chemical and physical characteristics of the lake catchments is explored.

1C01.3 ID:3355 14:30

Ectomycorrhizal Fungi and Biogeochemical Cycles: Rhizopogon in Whitebark Pine Forest Ecosystems

Lito Arocena , *Hugues Massicotte* , *Linda Tackaberry* , *Susan Robertson*
University of Northern British Columbia
Contact: arocenaj@unbc.ca

Symbiotic fungi in ectomycorhiza (ECM) associations assist plants in water and nutrient uptake from the soil. However, mechanisms in nutrient supply are largely speculative, especially the role of fungi in the synthesis of soil minerals. Here, we argue that ECM mantle hyphae and rhizomorphs are active sites for biogeochemical cycling through accumulation of calcium oxalate and synthesis of clay minerals. As part of our investigation into whitebark pine forest ecosystems in central British Columbia, we collected Rhizopogon -ECM root tips. Scanning electron microscopy (SEM) revealed all fungal surfaces had dense encrustations that consisted mainly of C (70-80 %), O (10–20 %) and Ca (4%) -rich block-like (2-5 μm) accumulations and isolated patches of “plate-like” (5-20 μm) materials characteristic of clay minerals. Other elements in the encrustations were Al (1-2 %), Si (1-2 %), Fe (5-8 %), Ni (2- 6 %), Mg (1-4 %), and K (0.5-1.0 %). X-ray diffraction analyses showed the presence of whewellite (CaC2O4 H2O), quartz (SiO2) and distinct reflections from ~10 to 12 nm regions indicating the presence of expanding 2:1 type of clays. We believe these observations are the first to describe clay formation on hyphae and rhizomorphs of Rhizopogon. Relatively higher amounts of Al than Si may indicate the chelation of Al with organic matter. Nickel and Fe may also be in chelated forms because we did not detect any crystalline Fe and/or Ni minerals. It is possible that Rhizopogon makes 2:1 clays on hyphal surfaces to ensure continuous supply of essential nutrients (K, Ca and Mg) that benefit whitebark pine. In addition, toxicities of Al (and Ni) are avoided through chelation by the fungal component. The ECM symbiosis between

Rhizopogon and whitebark pine is an example of important contributions of microorganisms to biogeochemical cycling in Earth's Critical Zone.

1C01.4 ID:3645 14:45

Prairie wetland drainage effects on water quality

Nathalie N. Brunet , *Cherie J. Westbrook*
Centre for Hydrology, Department of Geography and Planning, University of Saskatchewan, Saskatoon SK
Contact: n.n.brunet@gmail.com

The prairies contain millions of pothole wetlands that are typically small, shallow, and lack permanent surface water connections. They are thought to improve water quality in the prairies by acting as sinks for non point source loads. Recent agricultural intensification has lead to substantial wetland drainage throughout the prairies. Artificial ditches dug between wetlands and downstream surface waters are generally perceived to negatively impact water quality. However, wetlands can naturally form connections via the fill and spill mechanism. To investigate whether artificial ditches impact downstream waters differently than natural connections, water samples were collected along the length of seven artificial ditches and five natural connections from Smith Creek watershed, Saskatchewan during the snowmelt period of 2009 and analyzed for major ions, DOC, and nutrients. Artificial ditches were significantly longer, more channelized, and characterized by higher flow velocities. Nutrient and DOC concentrations and loads were also greater in artificial ditches. Normalized mass data show that nutrients and DOC were generally added along the length of both types of connections, with the exception of NO_3 and NH_4 that were removed along the length of artificial ditches and natural connections respectively. A wetland drainage experiment was also conducted. As the wetland drained, nutrient concentrations along the newly constructed ditch increased and exceeded seasonal averages measured in the wetland the previous year. Project results will be useful for making informed management decisions with regards to future pothole drainage or restoration, balancing public and private costs and benefits.

1C01.5 ID:3449 15:00

Hydrologic Profiling of Greenhouse Gases for Prairie Potholes in Saskatchewan

Richard Bourbonniere [1], *Irena Creed* [2], *Salvatore Spitale* [2], *Jennifer Adams* [2]
[1] Environment Canada, Water Science & Technology Dir.
[2] The University of Western Ontario, Dept. of Biology
Contact: rick.bourbon@ec.gc.ca

The Prairie Pothole Region (PPR), a unique physiographic region that covers a large portion of central Great Plains of North America, is predominantly grassland and populated with shallow depressions or "pothole wetlands" of varying size. Pothole wetlands generally fill with water after snowmelt forming ephemeral

ponds surrounded by concentric bands of soils with water contents that vary both in space and time and define the hydrologic profile of the wetland. Hydrologic profiles are important drivers of biogeochemical activity including transport of greenhouse gas (GHG) precursors from contributing source areas towards the ponds, influencing GHG exchanges. During the growing season of 2005 hydrologic profiles were defined for a series of natural or restored pothole wetlands at each of five nodes along a N-S climatic gradient in south central Saskatchewan. In 2006 a representative pond was selected at each node to determine GHG fluxes along the hydrologic profile on a 14-day repeat cycle from May-Sep. Overall growing season soil moisture and wetland average cumulative soil respiration (Rs) increased from south to north, but Rs is not evenly distributed across the hydrologic profile. The lower positions on the profiles, footslopes and toeslopes, yield the highest Rs which can total over the growing season 2-3 times those from the upper positions (crest, shoulder and backslope). Methane (CH4) fluxes at all five wetlands are almost exclusively from the inundated portion (pond) and begin to be significantly above baseline in June, earlier for the southernmost ponds, suggesting that temperature plays an important role initiating CH4 emissions. These natural and restored wetlands yielded little nitrous oxide (N2O) emissions overall. Wetland average cumulative N2O flux along the profile ranged from 58 to 577 gN2O-N/ha but showed no latitudinal trends. Several wetter topographic positions were “hotter” on some wetlands, the analogues of which may have dried before sampling began.

1C01.6 ID:3814 15:15

Manganese as a large-scale tracer of organic forcing in the Arctic Ocean; a look at sediment budgets

Robie Macdonald [1], *Charles Gobeil* [2]
[1] Fisheries and Oceans
[2] Université du Québec
Contact: robie.macdonald@dfo-mpo.gc.ca

It has long been known that Manganese (Mn) is sequestered in sediments under oxic conditions but may be set free to diffuse when organic metabolism is sufficient to use up the dissolved oxygen in pore waters. The redox structure in sediments, forced by labile organic loadings can lead to sediment surface enrichments of Mn under weak forcing, or the complete loss of reducible Mn with strong forcing. Although there exist many examples in the literature of Mn-enriched surface sediments, there are few, if any, examinations of how Mn is organized over entire ocean basins in response to the geographical distribution of organic fluxes that reach sediments. The Arctic Ocean contains the largest relative shelf area (~50%) of all oceans and it receives large inputs of dissolved and particulate material from rivers. The establishment of budgets for organic carbon and sediments for this ocean set the stage for the construction of mass balances. In this paper, we present the results of Mn core profiles for sediment cores extending from shallow shelf water to deep ocean basins and, for the first time, construct a balanced Mn budget for the entire ocean. These results have implications for shelf-basin exchange within the Arctic Ocean, the process of sediment metabolism as supported by oxygen carriers, and the global Mn cycle.

Lawrence Mysak Session on Ocean and Climate Dynamics (Part 2) / Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 2)

Room / Endroit (Ballroom C), Chair / Président (Bruno Tremblay), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C03.1 ID:3522 INVITED/INVITÉ 14:00

A tracer study of the Arctic Ocean's liquid freshwater export variability

Alexandra Jahn [1], *Bruno Tremblay* [2], *Robert Newton* [3], *Marika M. Holland* [1], *Lawrence A. Mysak* [2]

[1] National Center for Atmospheric Research, Boulder, USA
[2] Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada
[3] Lamont Doherty Earth Observatory of Columbia University, Palisades, USA
Contact: alexandra.jahn@mcgill.ca

Due to limited observations of the liquid freshwater (FW) export through Fram Strait and the Canadian Arctic Archipelago (CAA) and the fact that the FW in the upper ocean comes from many different sources (mainly river runoff, Pacific inflow, and sea ice melt), the variability of the liquid FW export from the Arctic Ocean is not well understood. To address this issue, we present an analysis of the variability of the Arctic FW export to the North Atlantic, using a simulation from the Community Climate System Model (CCSM), Version 3, that includes passive tracers that track FW from different sources. Using these tracers, we find that the FW exported through the western CAA comes mainly from the Pacific and from North American runoff. The variability of the FW export from both sources is generally in phase, due to the strong influence of the export velocity, and it is related to the large-scale atmospheric circulation (mainly the Arctic Oscillation). In Fram Strait, the FW export is mainly composed of Eurasian river runoff and FW of Pacific origin, which do not have a similar variability. The Eurasian runoff export depends strongly on the release of FW from the Eurasian shelf, which occurs during years with an anticyclonic circulation anomaly (negative Vorticity index) and takes 2-3 years to reach Fram Strait after leaving the shelf. The variability of the Pacific export on the other hand is mainly controlled by changes in the Pacific FW stored in the Beaufort Gyre, with increased export during years with a cyclonic circulation anomaly (positive

Vorticity index). Due to the different effect of the Vorticity index on the Pacific FW and the Eurasian runoff, the variability of the liquid FW export through Fram Strait is more complex than for the FW export through the CAA.

1C03.2 ID:3815 14:30

The influence of natural climate change on stained glass aesthetics during the middle ages

Christopher Simmons , *Lawrence Mysak*
McGill University
Contact: christopher.simmons@mail.mcgill.ca

As expressions of vernacular architecture, medieval Gothic churches often possess adaptations to their prevailing climate regime. The late medieval period in Europe is also marked by a transition from warm and sunny to cooler and cloudier conditions in the thirteenth and fourteenth centuries. It is within the context of this climate change that we consider interior daylighting, one of the most important features in Gothic churches, during the transition from the Medieval Warm Period (MWP) to the Little Ice Age (LIA). For the first time, an extensive data set of luminance and illuminance measurements has been collected in Gothic churches in France, Germany, and Spain. In addition, in order to determine the light-admitting capacity of windows from different eras, recent advances in HDR imagery were used to construct luminance fields and determine the relative transmissivities of authentic medieval windows. This quantitative overview reveals a significant increase in the use of high-translucency glazing, raising interior lighting levels by as much as an order of magnitude as precipitation and cloudiness increased in the late Thirteenth century. Furthermore, we determine that this clearer glass provided limited lighting gains compared to earlier programs under sunny conditions but substantial lighting improvements for cloudy conditions. The results suggest that the human response to naturally-induced climate change, as seen through the lens of architecture, may have been significant in the middle ages, providing important implications for the adaptability of construction in today's greenhouse era.

1C03.3 ID:3538 INVITED/INVITÉ 14:45

Coastal upwelling, river plume and bio-geochemical responses in the eastern Guangdong

Jianping Gan
Hong Kong University of Science and Technology
Contact: magan@ust.hk

Coastal upwelling circulation over the continental shelf in the eastern Guangdong of northeastern South China Sea (NSCS) is driven by the Asian southwesterly monsoon under strong influence of buoyant discharge of Pearl River and control of complex shelf and coastline topography. An intensified coastal upwelling off

eastern Guangdong is one of the most prominent coastal processes in the region. Algal blooms ensue as a result of nutrient enrichment by the intensified upwelling, Pearl River plume and intrinsic biogeochemical processes. These phenomena have been frequently observed from field and remote sensing measurements during summer over last decades, but the invoked processes and dynamics for this prominent shelf circulation in the southern China have not been established. This talk presents a novel 'myth' to illustrate intensified upwelling and corresponding bio-geochemical dynamics in the coast off eastern Guangdong.

1C03.4 ID:3806 15:00

Model study of interannual variability of the North Atlantic Water mass in the Arctic Ocean

Sarah Lundrigan , *Entcho Demirov*
Department of Physics and Physical Oceanography, Memorial University of Newfoundland
Contact: entcho@mun.ca

An ensemble hindcast study of the interannual variability of the North Atlantic Water (NAW) and the processes of its spreading and transformation in the Arctic Ocean is done using an Ocean General Circulation Model. The ocean model is a coupled ocean/sea-ice model (NEMO-OPA/ NEMO-LIM). The atmospheric forcing is calculated from NCEP/NCAR reanalysis. The changes in the volume flux of NAW over the Greenland-Scotland Ridge and through the Fram Strait and Barents Sea Opening are estimated and compared with observations. The related changes in the NAW mass properties and volume in the Arctic Ocean are studied.

1C03.5 ID:3997 INVITED/INVITÉ 15:15

Observed and modeled interacting jets and eddies in the North Pacific Ocean

David Dietrich [1], *Malcolm Bowman* [2]
[1] AcuSea, Inc.
[2] State U. of New York/Stony Brook
Contact: dietrich@nmia.com

Satellite altimetry shows three time mean fronts in the Kuroshio Extension region. They are also clearly seen in results from a 1/4 deg resolution global model. Animation and plots show that a strong eddy field is in near equilibrium with the associated three meandering jets. The field of the second moment of seasurface height time variations, compared to satellite altimetry, further validates the modeled eddies. The eddies entrain frontal water and mix it in regions between the fronts as they propagate upstream relative to the slower moving interfrontal mean flow. They usually reattach to the fronts, as theory suggests.

The Kuroshio current is unstable downstream of the Izu Ridge, where it escapes the constraints of the Honshu shelfslope. Nonlinear equilibration of the resulting eddies with the Kuroshio jet results in secondary fronts, as observed. Big meanders dominate near the surface, but eddies dominate the region of much slower mean flow away from (vertically and laterally) the meandering surface jet, even though the eddy (transient) velocities are biggest along the surface mean jet. In short, "separated free jets beget eddies beget jets beget eddies ..." Because of nonlinear equilibration and rotational constraints, interfrontal spacing naturally adjusts to the size of the most unstable eddies (related to the baroclinic internal Rossby radius of deformation). As the model dissipation is decreased, more and more energetic jets may form, but the number is limited by the resolution and domain size compared to the internal Rossby radius of deformation, which is much smaller in the ocean than in the atmosphere.

Uncertainty in climate change impacts to the water cycle (Part 2) / Incertitude quant aux effets du changement climatique sur le cycle de l'eau (Partie 2)

Room / Endroit (Richelieu), Chair / Président (Biljana Music), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C04.1 ID:3451 INVITED/INVITÉ 14:00

Managing uncertainty in the assessment of hydrological impacts of climate change

Howard Wheater
imperial college london
Contact: h.wheater@imperial.ac.uk

Climate change presents important challenges for water resources management. While there is high confidence that under climate change the hydrological cycle will intensify, with increased flood and drought risk, the capability of global climate models to represent precipitation is poor, and our understanding of catchment scale impacts on precipitation is highly uncertain. While there is a need to improve climate models, there is an arguably greater need to recognise the limits to predictability of climate change and address the scientific, technical and social aspects of adaptation to an uncertain future. The paper discusses new approaches to the use of climate model outputs for impacts assessment, and the need for improved interdisciplinary science to analyse and model land surface non-stationarity and understand potential effects on hydrological extremes.

Finally, it is argued that there are major advantages in moving from scenario analysis to vulnerability assessment to make informed decisions for water management under large uncertainty.

1C04.2 ID:3335 14:30

Developing a Climate Change Test Bed for the Lower Churchill Project

Amy Pryse-Phillips [1], *Ken Snelgrove* [1], *Jonas Roberts* [1], *Marion Organ* [2]
[1] Memorial University - Faculty of Engineering and Applied Science
[2] Nalcor Energy - Lower Churchill Project
Contact: amyprysephillips@hotmail.com

Future streamflow in the Churchill River is of great interest to Nalcor Energy, the new provincial energy corporation that is currently planning the development of a 3,074 MW hydroelectric project in Labrador, Canada. The study described here is part of a larger project being conducted at Memorial University to determine the potential impacts of climate change on the proposed Lower Churchill Project.

Past studies for Nalcor have reviewed IPCC documentation to determine the direction and regional magnitude of anticipated changes. These studies point to an increase in streamflow under climate change scenarios for central Labrador. To understand more about the local influences and details regarding the time evolution of these changes, detailed model studies have been initiated. Downscaled future climate scenarios from Regional Climate Models (RCMs) are used drive a hydrological model to assess impacts on localized streamflow. The WATFLOOD hydrological model has been selected for this purpose while the North American Regional Climate Change Assessment Program (NARCCAP) has served as the source of RCM data.

With WATFLOOD calibrated to reproduce streamflow for current climates, tests were initiated to determine the appropriateness of using synthetically generated RCM meteorology as forcing data. These tests revealed that while seasonal signals are captured for Labrador, considerable bias (underestimation of both precipitation and temperature) exist in RCM results. Correction of these biases required the use of non-linear procedures developed by Leader and Buishand (2007). These bias correction procedures, developed using periods of current climate, are applied to the future change scenarios such that the tri-decade periods of 1971-2000 and 2041-2070 are analyzed equivalently. Detailed assessment of results for the SRES A2 emissions scenario are currently ongoing. However, it appears that IPCC predictions of increased annual runoff for this region will be confirmed by this study.

1C04.3 ID:4169 14:45

Climate sensitivity of alpine snow regimes in the Canadian Rockies

John Pomeroy , *Matt Macdonald* , *Anne Sabourine*
University of Saskatchewan

Contact: john.pomeroy@usask.ca

Seasonal snow regimes in the alpine zone consist of snowfall, snow redistribution by wind, and snowmelt. Sublimation can be an important ablation mechanism under highly ventilated conditions. All of these processes are strongly controlled by the energy inputs and energy state of the snowpack. Warmer winter temperatures have been observed and are predicted for many cold regions environments. The Cold Regions Hydrological Model (CRHM) has the capability to successfully model the major snow processes in a physically based manner. It is used here to explore the sensitivity of snow regimes in the alpine zone of Marmot Creek Research Basin in the Canadian Rockies to warmer winter temperatures. Under current conditions, blowing snow redistributes most snowfall from wind exposed ridges and wind-ward slopes and deposits the transported snow in drifts on lee slopes, gullies, and below treeline. Sublimation losses from blowing snow are substantial. Melt occurs in May-July. Warming is shown to reduce sublimation losses somewhat - its restriction of wind redistribution overcomes effects from the additional sensible energy available for sublimation. However the reduced component of precipitation as snowfall under warmer conditions causes dramatically reduced winter snow accumulation. Warming advances the timing of snowmelt initiation, but reduces the rate of melt. The reduction in melt rate was not expected and is due to the snowmelt period being advanced into a time of year when radiative energy is smaller. The combination of lower snow accumulation, earlier melt and lower melt rate mean that the duration of melt initially drops and then increases as warming increases. These initial snow hydrology modelling results have important implications for determining the hydrological sensitivity of these cold regions environments to climate change.

1C04.4 ID:3344 15:00

Probabilistic climate scenarios development from an ensemble of regional climate model simulations using a weighting scheme: examples over the southern Québec

Hyung-Il Eum [1], *Philippe Gachon* [2], *René Laprise* [1]
[1] University of Quebec at Montreal
[2] Environment Canada
Contact: hieum@sca.uqam.ca

A number of climate models incorporating the cutting-edge techniques have been developed to provide more accurate projections for the global and regional-scale studies. However, inevitable uncertainties in climate scenarios due to the limitation in emission scenarios information or in physical parameterization of climate models can induce an unexpected misuse in post analyses. Since regional climate models (RCMs) with high spatial resolutions use the outputs from global climate models (GCMs) as boundary conditions, uncertainties in climate scenarios incorporate the combined errors from the GCM-RCM cascade or from the downscaling procedure. Therefore, these uncertainties should be

properly considered and addressed to alleviate an erroneous analysis in regional-scale climate change studies. An ensemble scenario technique aggregating a number of model simulations has been frequently employed to address the uncertainty of regional scenarios in a probabilistic framework. This study employs a weighting scheme that assigns a weighting (probability) to each climate model on the basis of ability to reproduce observed mean and extreme values, inter-annual variability, and multi-decadal significant trends for each climate variable of interest. Then this study will address advantages of the weighting scheme suggested in this study by comparing with simple weighting scheme. In addition, both marginal Probability Density Functions (PDFs) of single variables and joint PDFs of selected multiple variable combinations (e.g. surface air temperature and precipitation) will be developed as well as daily time series of temperature and precipitation from the ensemble members for the southern Québec region.

1C04.5 ID:3984 15:15

Uncertainties in Hydrologic and Climate Change Impact Analyses in Headwater Basins of British Columbia

Katrina Bennett , *Arelia Werner* , *Markus Schnorbus*
Pacific Climate Impacts Consortium
Contact: kbennett@uvic.ca

Preparation for water resource adaptation to climate change requires an accurate measure of the uncertainty associated with future projections of change to streamflow and water balance. This study examined hydrologic impacts in four BC watersheds (Fraser, Peace, Columbia and Campbell) for a range of downscaled Global Climate Model (GCM) emission scenarios to illustrate the uncertainty in hydrologic response to climate change. Uncertainties in water balance (runoff, evapo-transpiration, snow water equivalent (SWE), soil moisture) were analysed by forcing the Variable Infiltration Capacity (VIC) hydrologic model, run for 25 optimal parameter solution sets, with 10 Bias-Corrected Statistically Downscaled (BCSD) GCM emission scenario projections for the 2050s and the 2080s. The range in the 10 GCM-emission scenarios compared to the hydrological uncertainty of the 25 pareto solution parameterizations are greater between GCM-emission scenarios than the differences within the GCM-emission scenarios. Results show varying responses depending on geography and eco-climatic gradient of the basins. In general, there is little difference between scenarios in the 2050 results, but by the 2080s, the scenario differences begin to emerge. The 2050 projections show increases in winter runoff, decreases in summer runoff, variable responses in evapo-transpiration (increases or decreases) and decreases in April 1st SWE across BC. The greatest amount of projected change occurs during the winter period. For most water balance results, the 2080 projections are doubled from the 2050s results. Some scenarios project increased SWE in the Kicking Horse watershed (Columbia River basin) to the 2050s, while slight declines are projected for the 2080s. The responses to climate change are likely dependant on the hydrologic regime and physiography of an individual basin; therefore water managers who require an understanding of how climate change and uncertainty in climate change projections will impact their watersheds should consider conducting analysis on a range of GCM-emission scenarios, downscaled to their region of interest.

The Arctic Environment in the 21st Century / L'environnement arctique au 21e siècle

Room / Endroit (Frontenac), Chair / Président (James R. Drummond), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C05.1 ID:3712 **14:00**

Arctic Research in 2040

James Drummond
Dalhousie University
Contact: james.drummond@dal.ca

Cast you mind back to 1980 if you can. Google did not exist, microwave ovens were a novelty and VCRs were big and bulky. Personal computers were a dream. Satellite observations were just beginning. Research, particularly Arctic research was very much a hands-on, in the field activity.

In 2010 we have the internet in all locations to 80N, computers by the thousand and the possibility of remote access and remote control on a large scale. It is perfectly possible to operate equipment, even complex equipment such as lidars, remotely and many measurements can be fully automated. In the field it is expected that satellite maps can be downloaded in near real-time to plan a day's activities.

What will research be like in 2040? How will the availability of high bandwidth communications provided by new generations of satellites and new sensors affect the way we do research? Will everything be automatic? What will our graduate students do? Will new generations of computers and robotics mean that we will no longer be going North to do Arctic research? What will that mean for us, for our students and our Northern partners?

This talk is intended to provoke some discussion!

1C05.2 ID:3362 14:15

Hydrologic response of shallow lakes and ponds to recent climate change in the Hudson Bay Lowland near Churchill, Manitoba

Merrin Macrae , *Claude Duguay* , *Jennifer Parrott* , *Laura Brown* , *Nicolas Svacina*
Dept. of Geography & Environmental Management, University of Waterloo
Contact: mmacrae@connect.uwaterloo.ca

Recent ground-based and remote sensing observations have shown a general decreasing trend in arctic lake/pond surface area over the past 50 years, suggesting that small water bodies at high latitudes are drying. However, the majority of the work that has been done on drying ponds and shallow lakes has been conducted in Alaska and Siberia. The objectives of this work are (1) to examine trends and seasonal variability in pond and shallow lake water levels and surface area during the open water season; and (2) to examine trends and variability in the duration of ice cover in ponds and shallow lakes in this region, as open water season evaporation totals have been shown to be strongly influenced by ice cover duration. Climatic change and changes to pond hydrologic storage over the past 53 years were examined using a combination of field methods/instrumental records, modelling and remote sensing/imagery analyses. Results show that both annual precipitation and evaporation have increased between 1955- 2008; however, rainfall appears to be increasing more than evaporation. Consequently, the summer moisture deficit appears to be lessening and conditions are becoming more wet. A change detection study conducted on a subset of ponds for four years using air photographs and a SPOT image show that pond surface areas appear to have fluctuated over the study period but have not increased in size. Results from simulations of pond ice thickness, break-up and freeze-up dates, and duration of open water season between 1955-2008 suggest that temperatures are warming in this region. Correspondingly, break-up appears to be occurring earlier and freeze-up appears to be occurring later, leading to a prolonged ice-free season. The approaches developed in this study could form the basis of a general methodology for investigating the contemporary status of ponds and shallow lakes in the Arctic.

1C05.3 ID:3840 14:30

Permafrost and climate change at Illisarvik, Mackenzie delta region, western Arctic coast, Canada

Christopher Burn , *Yinsuo Zhang*
Department of Geography and Environmental Studies, Carleton University
Contact: yinsuo_zhang@carleton.ca

Canada's western Arctic has experienced greater atmospheric warming since 1970 than most other areas of the country, with the rate of increase in mean annual air temperature being 0.77ºC/decade. There is an air temperature record for the Mackenzie delta area since 1926, but before 1970 there was only slight

warming. In 1974, J. R. Mackay published a baseline map of permafrost temperatures in the area, which were 1º – 3ºC lower than present measurements of annual mean ground temperature. At Herschel Island, 100 km west of the delta, the temperature profile in permafrost has been reconciled with climate warming during the 20th century using a numerical simulation.

Illisarvik is a long-term field site for permafrost investigations on Richards Island, established by J. R. Mackay in 1978. In 2006 and 2008 we drilled bore holes to 50- and 53-m depth, at sites in undisturbed tundra, cased the holes with one-inch steel pipe, and installed temperature cables with thermistors spaced at 5 m intervals in the casing. These sites have provided temperature profiles of identical gradient, but offset by about 0.4ºC. The profiles decrease in temperature with depth, indicating recent warming of the ground. The temperatures at 20-m depth are -7.1ºC and -6.8ºC, over 1ºC warmer than data from 1970; at the surface the increase is close to 3ºC. We have reproduced the temperature profile at the site with a similar numerical simulation as for Herschel Island, but with the warming concentrated in the last 40 years. The simulation was calibrated against deep temperature records available for the area and a regional heat flux of 0.05 Wm-2. The thermal conductivity of the sand formations in the area, which extend below 100 m depth, is relatively high. The simulation indicates the thermal regime has been disturbed from equilibrium to about 100-m depth.

1C05.4 ID:3333 14:45

Extreme low sea ice years in the Canadian Arctic Archipelago

Stephen Howell [1], *Adrienne Tivy* [2], *Tom Agnew* [1], *Thorsten Markus* [3], *Chris Derksen* [1]
[1] Environment Canada
[2] International Arctic Research Center
[3] Cryospheric Sciences Branch, NASA Goddard Space Flight Center
Contact: Stephen.Howell@ec.gc.ca

Extreme sea ice minima are observed within the Canadian Arctic Archipelago (CAA) during 1998 and 2007. September sea ice area is -2.90 and -2.65 standardized anomalies below the historical 1968 to 1996 climatology for 1998 and 2007, respectively. October sea ice area for 1998 is a staggering -4.45 standardized anomalies below the historical 1968 to 1996 climatology and 2007 is lower than -3.36 standardized anomalies. We examine the role of thermodynamic and dynamic forcing on CAA sea ice that is responsible for its extreme loss in 1998 and 2007. Thermodynamic forcing on the sea ice is concentrated in 2007 facilitating rapid melt, contrasted against a long melt season in 1998. This variation is attributed to anomalously warm temperatures in June, September, and October for 1998 compared to anomalously warm temperatures in July for 2007. Sea ice dynamics contribute to the 1998 minimum by inhibiting replenishment from the Arctic Ocean but facilitate replenishment in 2007 preventing record low conditions. Replenishment is driven by dissimilarities in sea level pressure patterns over the CAA during these extreme years.

Evidence for pre-conditioning is apparent leading up to 2007 but not for 1998. Remarkably, at the onset of 1998 multi-year ice area within the CAA is 11% above the historical climatology and 19% more than 2007 yet, extreme minima is still reached.

1C05.5 ID:3891 15:00

Measurements of stratospheric trace gases above Eureka from 2006 to 2010

Cristen Adams [1], *Kimberly Strong* [1], *Rodica Lindenmaier* [1], *Rebecca Batchelor* [1], *Annemarie Fraser* [1], *Joseph Mendonca* [1], *Jim Drummond* [2], *Chris Mclinden* [3], *Gloria Manney* [4], *William Daffer* [4]
[1] Department of Physics, University of Toronto, Toronto, Canada
[2] Department of Physics and Atmospheric Sciences, Dalhousie University, Halifax, Canada
[3] Experimental Studies Division, Environment Canada, Downsview, Canada
[4] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA
Contact: cadams@physics.utoronto.ca

Stratospheric ozone is a well known absorber of UV radiation. In the Arctic, ozone concentrations are tied to stratospheric dynamics and concentrations of other highly variable trace gases. Therefore, year-to-year and season-to-season, Arctic stratospheric ozone concentrations vary greatly. Anthropogenic halogen emissions and climate change complicate this system further. For example, greenhouse gases change the stratospheric temperature, which affects dynamics and chemistry, and ultimately impacts ozone concentrations. Furthermore, halogens cause chemical ozone depletion, which decreases radiative forcing to the stratosphere, and may also change stratospheric dynamics. In turn, this can lead to more changes to ozone concentrations. In order to understand this complex system, long-term measurements of the composition of the Arctic stratosphere are necessary. We will present the first three and a half years of an effort to build a long-term stratospheric composition dataset at the Polar Environment Atmospheric Research Laboratory in Eureka, Canada (80N, 86W), as part of the Canadian Network for the Detection of Atmospheric Change. We will discuss the variability of Arctic ozone, and related constituents through the sunlit parts of Fall 2006 to Spring 2010 measured by two ground-based UV-visible spectrometers and a Bruker 125HR Fourier transform infrared spectrometer. We will investigate the seasonal, day-to-day, and diurnal variations of these species and will relate these measurements to available sunlight and dynamical conditions above Eureka.

Ocean Climate Change, Variability and Impacts (Part 2) / Changements et

variabilité du climat océanique et leurs effets (Partie 2)

Room / Endroit (Joliet), Chair / Président (Michael Foreman), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C06.1 ID:3708 14:00

Climate variability in the Northwest Atlantic, the decade in review

Eugene Colbourne
Fisheries and Oceans, Canada
Contact: colbourn@dfo-mpo.gc.ca

An analysis of decadal changes in the meteorological and hydrographic climate variability in the Northwest Atlantic is presented based on data from fixed stations, cross-shelf sections and from fishery resource assessment surveys. The results show significant variability at annual, decadal and multi-decadal scales with the 1950s and particularly the 1960s the warmest decades during the latter half of the 20th century on the Newfoundland and Labrador Shelf. The decades of the 1970s, 1980s and 1990s experienced extreme intra-decadal variability with the early years of each decade generally colder and fresher than normal that warmed to above normal conditions during the latter half of each decade. The decadal averaged salinity indicate that the magnitude of negative salinity anomaly on the inner Newfoundland and Labrador Shelf during the 1990s exceeded that observed in the early 1970s and in fact was the freshest anomaly in the 60-years of measurements off eastern Newfoundland. The decade of the 1990s experienced the most extreme variability with ocean temperatures ranging from record low values during 1991 to near-record highs during 1999 in many areas, particularly on the Grand Bank of Newfoundland. The first decade of the 21st century on the other hand saw both air and ocean temperatures well above normal throughout the 2000s, making it the warmest decade in over 60 years of ocean measurements and over 130 years of air temperature measurements.

1C06.2 ID:4091 14:15

Recent Variability in Ocean Climate and Lower Trophic Levels in the Labrador Sea

Blair Greenan , *Igor Yashayaev* , *Kumiko Azetsu-Scott* , *Glen Harrison* , *Erica Head* , *Bill Li* , *John Loder* , *Phil Yeats*
Fisheries and Oceans Canada, Bedford Institute of Oceanography
Contact: John.Loder@dfo-mpo.gc.ca

The Labrador Sea is an important area for both the coupled global climate system and the regional ocean climate and ecosystems off Atlantic Canada. Consequently, it is a focal area in the Atlantic Zone Off-Shelf Monitoring Program

(AZOMP) of Fisheries and Oceans Canada (DFO). Observations from an annual physical-chemical-biological oceanographic survey on the AR7W line extending from Labrador to Greenland, Argo floats, remote sensing and other sources are used to describe and study its climate and lower-trophic-level variability, as part of DFO's ocean climate and ecosystem program. This presentation will provide an update on recent variability in the region, ranging from physical oceanographic properties such as temperature, salinity, stratification and deep convection, through chemical properties such as oxygen, nutrients and acidity, to biological properties such as microbial, phytoplankton and zooplankton biomass and production. Apparent recent trends in properties such heat and freshwater, nutrients, acidity and plankton abundance will be discussed in relation to the possibilities for natural and/or anthropogenic origin.

1C06.3 ID:4092 **14:30**

Recent Variability in Ocean Climate in the Scotia-Maine and Adjacent Regions

Brian Petrie , *Roger Pettipas* , *Charles Hannah*
(Presented by *Charles Hannah*)
Fisheries and Oceans Canada, Bedford Institute of Oceanography
Contact: John.Loder@dfo-mpo.gc.ca

Fisheries and Oceans Canada (DFO) has been monitoring ocean climate and lower-trophic-level variability in the Atlantic Canadian shelf/slope region since 1996, through a zonally-coordinated program called the Atlantic Zone Monitoring Program (AZMP). The program includes surveys, fixed stations, coastal measurements, remote sensing and use of other relevant atmospheric, ice and ocean data. This presentation will provide an overview of recent variability in physical oceanographic conditions with focus on the Gulf of St. Lawrence to Gulf of Maine region. Variability in sea level, ocean temperature and salinity, and stratification will be reported. Results indicate that there are significant long-term changes.

1C06.4 ID:4099 **14:45**

Ocean deoxygenation and climate change: model predictions and observations

Denis Gilbert
Institut Maurice-Lamontagne, Pêches et Océans Canada
Contact: denis.gilbert@dfo-mpo.gc.ca

Climate change scenarios from global atmosphere-ocean climate models with embedded NPZD (Nutrients, Phytoplankton, Zooplankton, Detritus) models predict that oxygen concentrations in the ocean will decrease about 3 times faster than might be expected from changes in temperature- and salinity-dependent oxygen solubility alone. Global oxygen decline rates vary from one model to another, but range from about 0.02 to 0.10 umol kg-1 yr-1. A first

cursory look at Winkler titration oxygen data from the global ocean gives mean oxygen decline rates in the open ocean (more than 100 km from the coastline) that overlap model predictions. In the coastal ocean (less than 30 km from the coastline), oxygen decline rates are more rapid at 0.35 umol kg-1 yr-1 on average, probably due to eutrophication from nutrient-rich river and groundwater discharges into the coastal zone. However, these oxygen trend estimates from bottle data are based on spotty, ship-based oxygen measurements with very poor spatial coverage of the global ocean. To provide better tests of the predicted rates of ocean deoxygenation from global climate change models, we need to put in place and maintain a better system of oxygen monitoring. In areas of the open ocean deeper than 2000 m, about 150 of the 3000 Argo floats are presently equipped with oxygen sensors. Early results from this pilot array of Argo oxygen floats will be presented.

1C06.5 ID:3822 15:00

Regime Shift in the Gulf of Maine

Peter Smith [1], *Neal Pettigrew* [2], *Guoqi Han* [3]
[1] Bedford Institute of Oceanography
[2] University of Maine
[3] Northwest Atlantic Fisheries Centre
Contact: Peter.Smith@dfo-mpo.gc.ca

Conventional wisdom, based on observations spanning roughly two-and-a-half decades is that inflow to the Gulf of Maine occurs primarily in two locations: inshore on the Scotian Shelf off Cape Sable, NS, and on the eastern side of the Northeast Channel (NEC). In particular, the monthly mean currents in the NEC show persistent inflow at all depths and in all seasons, except for the occasional reversals near the bottom (~200m). Conversely, the flow on the western side of the NEC is normally directed out of the Gulf in the surface layers, consistent with the clockwise gyre over Georges Bank, but those currents do show relatively frequent reversals to inflow in the deeper layers (150-200m), in sympathy with the flow on the eastern side. Another feature of the GLOBEC observations, when both inflow components were monitored (1993-’97), is the strong inverse correlation between the Cape Sable and deep (>75m) NEC inflows. At some point after the removal of the last BIO/GLOBEC mooring in 2000, and 2004, when a new mooring was placed there as part of the US ocean observing array (NERACOOS), a transformation of this picture occurred. Recent profiling current meter data from a location in the eastern NEC that lies among the historical moorings sites, show a strongly seasonal current signal, marked by persistent periods of outflow in the deep layers, particularly in winter. Moreover, the outflow currents occasionally extend to the surface layers as well, most notably in the winter of 2004-’05. This new mode of behaviour in the NEC currents could have important consequences for the Gulf of Maine ecosystem. In this talk, the evidence of, and a possible dynamical mechanism for, this “regime shift” in the NEC circulation and eastern Gulf of Maine will be explored, along with some implications for the Gulf ecosystem.

1C06.6 ID:4090 **15:15**

Projecting Ocean Climate Change in the NW Atlantic

John Loder [1], *Augustine Van Der Baaren* [2], *Brian Petrie* [1], *Igor Yashayaev* [1]
[1] Fisheries and Oceans Canada, Bedford Institute of Oceanography
[2] Bedford Institute of Oceanography
Contact: John.Loder@dfo-mpo.gc.ca

Challenges and potential approaches to the projection of ocean climate off Atlantic Canada are discussed, and some probable significant changes are indicated. A major challenge is the region's location downstream of Arctic outflows and in the confluence zone of the western boundary currents (Labrador Current, Gulf Stream) of the North Atlantic's two major circulation gyres (subpolar, subtropical). As a result, regional ocean influences are very important. Further, there is increasing evidence of strong influences from natural modes of climate variability such as the North Atlantic Oscillation, such that natural climate variability may predominate over anthropogenic change for the next few decades. Comparison of the spatial and temporal variability in selected IPCC AR4 model simulations with observed ocean temperature, salinity and sea ice variability indicates that, while some features of the major gyres are represented, other important features are not. This means that dynamical downscaling is difficult. A complementary triage approach is suggested, using available knowledge of the regional ocean climate, global projections and regional (downscaling) models to identify the climate variables and features with the greatest likelihood of change. The results of this could then be used with an assessment of the potential impacts on valued resources to provide indications of the greatest risks and vulnerabilities. A review of the climate change literature together with consideration of the regional ocean dynamics and valued resources indicates that probable significant regional ocean climate changes include rising sea level, ocean acidification, upper-ocean warming and freshening resulting in increased stratification, and reduced seasonal ice cover. It may be more difficult to project climate change downstream of the Grand Bank than upstream where atmospheric and hydrological changes are expected (with more confidence) to be greater, and atmospheric influences on the ocean appear to be more direct.

Coupled Atmosphere-Ocean Prediction and Predictability (Part 2) / Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 2)

Room / Endroit (Chaudière), Chair / Président (William J. Merryfield), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C07.1 ID:3999 14:00

Relationship of seasonal climate forecast error to uncertainty in soil moisture initializations

Nasim Alavi [1], *Aaron Berg* [1], *Gordon Drewitt* [1], *Bill Merryfield* [2]
[1] University of Guelph, Department of Geography
[2] Canadian Centre for Climate Modelling and Analysis
Contact: nalavi@uoguelph.ca

Accurate initialization of General Circulation Models (GCM) with realistic global field of soil moisture data can improve the seasonal and sub-seasonal predictions of atmospheric states. In the second Historical Forecasting Project (HFP2), the third generation Canadian Center for Climate Modeling and Analysis (CCCMA), atmospheric general circulation model (GCM3) was run to produce a series of four-month forecasts over a 33-year period. For the HFP project, the land surface wetness state was initialized from model climatology rather than realistic estimates of the initial soil moisture state. In this study we investigate the effect of soil moisture initialization on the monthly predictions of air temperature and precipitation evident in the HFP. Global estimation of soil moisture was obtained using the Canadian LAnd Surface Scheme (CLASS), which was forced with meteorological data, derived from the NCEP/NCAR reanalysis corrected to observations. Initialization errors in the HFP were calculated based on the differences between CLASS generated soil moisture data for each Boreal warm season month and the model climatology. Seasonal forecast errors of HFP monthly temperature and precipitation were estimated by comparison to observations. The statistical relationships between the initialization and forecast errors were assessed to detect the regions where the initialization error has the highest influence on the seasonal forecast skill. The results demonstrate that soil moisture initialization errors have the greatest impact on seasonal forecasts of temperature and precipitation over equatorial Africa, central North America and India. For temperature the magnitude and the areal extent of this effect was greater than that for precipitation.

1C07.2 ID:3674 14:15

The role of soil moisture initialization in forecasting drought occurrence

Gordon Drewitt [1], *Aaron Berg* [1], *Bill Merryfield* [2], *Woo-Sung Lee* [2]
[1] University of Guelph
[2] Canadian Center for Climate Modelling and Analysis
Contact: gdrewitt@uoguelph.ca

The occurrence of drought can impose economic cost to many sectors of the economy. Any ability to improve the prediction of drought could find practical application for governments and industry. As part of the Global Ocean-

Atmosphere Prediction and Predictability (GOAPP) project and the Drought Research Initiative (DRI), we are examining the role of land surface initialization and its influence on seasonal forecasts and drought conditions. We have developed a dataset of global soil moisture spanning 29-years at a 2.5 degree resolution. This land surface data was used to initialize two sets of 60-day, 10-member ensembles of seasonal forecasts during the boreal summer. One of the forecast sets was initialized with the real land surface data while the other set was initialized with the same data but randomly shuffled by year. This presentation will show preliminary comparison of the model forecast performance with specific regard to capturing the onset of drought conditions.

1C07.3 ID:3670 14:30

Assesing the performance of a Northwest Atlanctic ocean circulation model using the spectral nudging and the semi-prognostic methods

Jorge R. Urrego-Blanco , *Jinyu Sheng*
Department of Oceanography. Dalhousie University.
Contact: jorge.urrego.blanco@dal.ca

The spectral nudging method (Thompson et al. 2006) and the semi-prognostic method (Sheng et al. 2001) were developed to reduce errors in ocean circulation models. In this study we assess the performance of these two methods using a (1/4°) resolution ocean model constructed from OPA (Océan PArallélisé). The model domain covers the region between 32°W and 81°W and between 33°N and 57°N. The model is forced by atmospheric reanalysis fields produced by Large and Yeager (2004) and monthly mean climatologies of temperature and salinity produced by Geshelin et al. (1999). Four different numerical experiments are conducted, which are: a) a fully prognostic run; b) a run using the spectral nudging method; c) a run using the smoothed semi-prognostic method (Eden et al. 2001); and d) a run using a combination of the spectral nudging and the smoothed semi-prognostic methods with weaker nudging coefficients. We demonstrate that the model run with the combined approach reproduces the general circulation and associated mesoscale variability reasonably well. The model results in the fourth experiment are used to examine the interannual to decadal variabilities of the Sea Surface Temperature (SST) over the area of the Scotian Shelf and Slope during the 17-year period of 1988-2004. Over this area, similar variabilities can also be found from model results throughout the entire water column and particularly in the upper (~0-50 m) and middle (~50-1000 m) water columns. We discuss the role of the local heat flux, the Gulf Stream and the Labrador Current in affecting the low frequency temperature variability over this study area.

1C07.4 ID:4067 14:45

New Developments in Spectral Nudging

Dan Wright [1], *Simon Higginson* [2], *Yimin Lu* [3], *Keith Thompson* [2], *Zeliang Wang* [1]
[1] Bedford Institute of Oceanography

[2] Dalhousie University
[3] Northwest Atlantic Fisheries Centre
Contact: Dan.Wright@dfo-mpo.gc.ca

Spectral nudging constrains an ocean model to be close to a specified climatology within specified frequency and wavenumber bands while leaving the variability outside of these bands free to evolve according to the model's dynamics. It is clear that the specification of accurate climatological information is critical to the success of the method. In this talk we discuss two approaches that have been developed to improve the performance of spectral nudging. In the first approach, we develop a very efficient spatial filter that operates selectively on low frequencies and is designed to work effectively even in areas of complex topography. This approach can be used to filter out small scales in the climatology that are not well determined by observations and also allows the model's mean density field to adjust to the discretized bottom topography. The filtering approach will be described and the frequency-dependent gain of the filter will be presented. In the second approach, we develop a new climatology for the North Atlantic which takes advantage of a recently developed de-eddying technique plus altimetry and Argo data. The result is a new climatology that is consistent with recent conditions and less contaminated by eddy variability. Results obtained using the two approaches are compared with previous results, with each other, with a hybrid approach and finally with independent observations.

1C07.5 ID:3384 15:00

Simulation of the Mixed-Layer Depth in the North East Pacific implementing Spectral Nudging

Shawn M. Donohue , *Michael W. Stacey*
Royal Military College of Canada
Contact: shawn.donohue@rmc.ca

A 46 year simulation (1960-2006), using the Parallel Ocean Program, of the circulation of the Northeast Pacific (NEP) is used to study the properties of the mixed layer depth (MLD). Spectral nudging is used to prevent model drift from Levitus climatology. The horizontal resolution of the model is 0.25 degrees, and there are 28 unequally spaced vertical levels. The vertical grid spacing in the upper 150 m is 10 m. The model is forced by monthly NCEP windstress, surface heatflux, freshwater flux, and surface pressure. The implementation of spectral nudging greatly improved the simulations. The winter MLD is defined as being the depth where sigma-t is 0.1 greater than the surface value. Simulated MLD trend maps indicate significant shoaling from the beginning of the simulation until peaking in 2003 in the Gulf of Alaska (GOA), particularly along the coast, with larger rates of shoaling in the northern GOA. The rate of shoaling is similar to scales found in past studies, and is consistent with the observed freshening and warming of the upper waters in the GOA. The simulated low frequency MLD variability is found to be in good agreement with the available observations. The

observed strong variability and historic shoaling of the MLD in 2003 and subsequent deepening by 2006 is reproduced by the model. A significant increase in stratification by 2002 resulted in an anomalously shallow MLD in the winter/spring of 2003. Strong and relatively isolated Ekman pumping is shown to be the cause of this shoaling, in concert with a relatively large positive salinity anomaly at depth. Relaxation of the Ekman pumping later in the autumn and the decay of the Aleutian Low Pressure System returns the MLD to historical levels by 2006.

1C07.6 ID:3898 15:15

Meridional heat transport simulated with a high-resolution North Atlantic model

Youyu Lu [1], *Wensheng Jiang* [2], *Frederic Dupont* [3]
[1] Bedford Institute of Oceanography
[2] Ocean University of China
[3] Environment Canada
Contact: LuY@mar.dfo-mpo.gc.ca

The general circulation and meso-scale eddies in the North Atlantic (NA) are simulated with the NEMO ocean model. The horizontal resolution of the model is 1/4º for the whole NA basin and 1/12º for the Gulf Stream region, using the two-way embedding technology. The model results are analyzed to derive estimates of the meridional heat transport (MHT). In the Gulf Stream region, it is found that the MHT from the basin model and the embedded sub-model are very close to each other, confirming that two-embedding improves the solution of the basin model. The spatial structures of the MHT due to the time-mean circulation and eddies are mapped out and compared with each other.

Stratospheric Processes and their Role in Climate (Part 2) / Les processus stratosphériques et leur incidence sur le climat (Partie 2)

Room / Endroit (Capitale), Chair / Président (Theodore G. Shepherd), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C08.1 ID:3457 INVITED/INVITÉ 14:00

Quantitative Performance Metrics for Stratospheric-Resolving Chemistry-Climate Models

Darryn Waugh
Johns Hopkins University
Contact: waugh@jhu.edu

The use of observationally-based performance metrics was a key aspect of the recent SPARC Chemistry-Climate Model Validation (CCMVal) report. I will show how application of these metrics quantified the ability of chemistry-climate models to reproduce key processes for stratospheric ozone. The use of metrics also enabled easy recognition of the models' performance for multiple aspects of the simulations, identification of missing or incompletely modelled processes, and quantitative assessment of model improvements (both for different versions of individual CCMs and between CCMVal-1 and CCMVal-2). I will also discuss some of the issues with the application and interpretation of performance metrics that need future examination.

1C08.2 ID:3849 14:30

Attribution of observed stratospheric temperature and ozone changes using chemistry-climate model simulations

Nathan Gillett
CCCma, Environment Canada
Contact: nathan.gillett@ec.gc.ca

Most previous studies attempting to identify the causes of observed stratospheric temperature and ozone changes have relied on qualitative comparison of the observed changes with the simulated response to anthropogenic emissions of ozone depleting substances (ODSs) and other greenhouse gases (GHGs). Here we use optimal detection techniques commonly applied to surface temperature to compare observed changes in stratospheric temperature and ozone with the simulated responses to emissions of ODSs and GHGs. This analysis will make use of newly-completed sets of chemistry-climate model simulations with fixed greenhouse gases and sets of simulations with fixed halogens, together with MSU/SSU temperature observations, and SBUV/SAGE ozone measurements. This analysis allows us to identify the extent to which the effects of ODSs and GHGs are identifiable and separable in the observed record of stratospheric temperatures and ozone, and to identify the components of observed changes which are attributable to ODS and GHG emissions.

1C08.3 ID:3956 14:45

Assessment of multiple linear regression as a tool for attribution of stratospheric temperature and ozone changes

Andreas Jonsson [1], *Victor Fomichev* [2], *David Plummer* [3]
[1] University of Toronto
[2] York University
[3] Canadian Centre for Climate Modelling and Analysis
Contact: andreas.jonsson@utoronto.ca

Multiple Linear Regression (MLR) can be applied to coupled chemistry-climate model results in order to estimate the individual effects of different forcings on simulated variables. For example, in an earlier study we applied MLR to the results from a transient simulation over 1960-2100 with the Canadian Middle atmosphere Model (CMAM) in order to attribute past and future changes in stratospheric ozone and temperature to changes in greenhouse gases (GHGs) and ozone depleting substances (ODSs). We noted, however, that MLR assumes that sensitivities are linear, and furthermore, that regressors must be sufficiently orthogonal to clearly separate between the effects of the considered forcings. Thus MLR attribution results can be associated with significant uncertainty.

In this study we examine a new set of CMAM simulations for which the GHG and ODS forcings were added individually in separate simulations, providing the true response of stratospheric ozone and temperature to the applied forcings. Comparison of these new results with attribution estimates achieved from MLR analysis of a simulation including all considered forcings simultaneously enables us to explore how well MLR analysis performs in different regions of the stratosphere and for different sets of explanatory variables. Furthermore, this allows us to evaluate the intrinsic limitations of MLR analysis for stratospheric attribution, estimate uncertainties and examine non-linear behavior in the system.

1C08.4 ID:3493 15:00

Simulating the past, present and future of the upper troposphere and lower stratosphere

Michaela I. Hegglin [1], *Andrew Gettelman* [2], *Ccmval Team* [3]
[1] University of Toronto
[2] NCAR
[3] various institutions
Contact: michaela@atmosp.physics.utoronto.ca

A comprehensive assessment of coupled chemistry climate model (CCM) performance in the upper troposphere and lower stratosphere has been conducted with 18 models. Both qualitative and quantitative comparisons have been conducted, the latter using a collection of quantitative grading techniques. The models are able to reproduce the observed climatology of dynamics, thermal and tracer distributions in the tropical and extratropical UTLS, despite relatively coarse vertical and horizontal resolution. Diagnostics of the Tropical Tropopause Layer (TTL), Tropopause Inversion Layer (TIL) and Extra-tropical Transition Layer (ExTL) are analyzed. The results provide new insight into key processes that govern the dynamics and transport in the tropics and extra-tropics to explain how models are able to reproduce key features, and what features they do not reproduce. Model trends over the historical period are also assessed and interannual variability is included in the metrics. Finally, key trends in the UTLS for the future with a given halogen and greenhouse gas scenario are presented, indicating significant changes in tropopause height and temperature, as well as

UTLS ozone concentrations.

1C08.5 ID:3456 15:15

Diagnosing the stratosphere-troposphere stationary wave response to climate change in chemistry-climate models

Lei Wang , *Paul Kushner*
University of Toronto
Contact: lei@atmosp.physics.utoronto.ca

The zonally asymmetric component of the climatological mean atmospheric circulation, known as the “stationary wave”, is an essential aspect of the global climate and is closely related to regional climate as well. Chemistry-Climate Models (CCMs) have simulated significant changes in the stationary wave field in response to climate change, especially in the stratosphere. Stationary wave models are simplified atmospheric models that elucidate the stationary wave dynamics. Past stationary wave models largely focused on tropospheric circulation, but the stationary wave field extends into the stratosphere and plays an important dynamical role there. We here apply a recently developed stationary wave model that captures both the stratospheric and tropospheric stationary waves to the question of the stationary wave response to climate change. We use this model to diagnose the stationary wave response to climate change in the CCM simulations and to separate the effects of the changes in the zonally asymmetric diabatic heating and the changes in the zonal mean state on this response. We find that in these simulations the zonal mean flow changes play a major role in explaining the stationary wave response, especially in the stratosphere, while the diabatic heating changes are only responsible for a modest portion of the total stationary wave response. Further decomposition of zonal mean changes has revealed that the stationary wave response is largely controlled by specific localized features of the zonal mean changes.

Drought, Climate and Society (Part 2) / Sécheresse, climat et société (Partie 2)

Room / Endroit (Panorama), Chair / Président (John Pomeroy), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C09.1 ID:3518 14:00

The surface-convection feedback during drought periods on the Canadian prairie

Julian Brimelow [1], *John Hanesiak* [1], *William Burrows* [2]

(Presented by *Julian Charles Brimelow*)
[1] University of Manitoba
[2] Cloud Physics and Severe Weather Research Section, Environment Canada
Contact: umbrimel@cc.umanitoba.ca

Linkages between the terrestrial ecosystem and precipitation play a critical role in regulating regional weather and climate. These linkages can manifest themselves as positive or negative feedback loops, which may either favour or inhibit the triggering and intensity of thunderstorms. While the Canadian prairie terrestrial ecosystem has been identified as having the potential to exert a detectable influence on convective precipitation during the warm season, little work has been done in this area using in-situ observations.

We present findings from a novel study designed to explore linkages between the Normalized Difference Vegetation Index (NDVI), and lightning duration (DUR) from the Canadian lightning detection network. Calculations were made for 38 Census Agriculture regions for summers (JJA) between 1999 and 2008. Specifically, correlation coefficients were calculated between pairs of standardized anomalies of DUR and NDVI by season and by month. Correlations were also made for CARs grouped by size and/or by magnitude of the NDVI anomalies.

The main findings are: (1) JJA lightning activity is overwhelmingly below average within "larger" "dry areas" (i.e., areas with below average NDVI); that is, the linkages between NDVI and DUR increased significantly as both the area and magnitude of the dry anomaly increased. (2) In contrast, CARs having above average NDVI did not consistently experience above average lightning activity, regardless of the CAR size; (3) The lower threshold for the area of the dry anomalies required to affect the boundary layer sufficiently to reduce lightning activity was found to be approximately 150 km; (4) our analysis suggests that the surface-convection feedback appears to be a real phenomenon, in which drought tends to perpetuate drought with respect to convective storms and associated rainfall, within the limits found in (1) and (3).

1C09.2 ID:3775 14:15

Determining prairie hydrological drought by modeling

Kevin Shook , *John Pomeroy*
Centre for Hydrology, University of Saskatchewan
Contact: kevin.shook@usask.ca

The prairie drought of 1999-2005 was the worst in modern Canadian history. On the Canadian prairies, much of the land is not connected to a defined drainage system, but drains internally, so the extent, intensity and duration of the hydrological drought are difficult to quantify from streamflow records. Moreover, many of the processes crucial to understanding the hydrological drought, such as evaporation, and the redistribution and sublimation of the winter snowpack through wind transport are not currently measured. CRHM (Cold Regions Hydrological Model) is a physically-based model developed at the Centre for Hydrology at the University of Saskatchewan which is able to accurately simulate prairie hydrological processes. Two “virtual” watersheds typical of prairie hydrography were constructed: a small stream surrounded by uplands, and a complex of inter-connected wetlands. The behaviors of the virtual watersheds were simulated at a number of locations over the prairie region during the climate normal period of 1961-1990, and during the drought period of 1999-2005, and values were determined for variables of interest including snow accumulation, soil infiltration, basin runoff, and evapotranspiration. Exceedance fractions of the normal period values were calculated from the drought period values and these fractions were gridded to create surfaces describing the extent and evolution of the hydrological drought throughout the prairies.

1C09.3 ID:3652 14:30

Groundwater and drought in the prairies – what observation well data can tell us

Garth Van Der Kamp [1], *Masaki Hayashi* [2]
[1] Environment Canada
[2] Geology and Geophysics, University of Calgary
Contact: garth.vanderkamp@ec.gc.ca

For much of the prairie region the water table lies within several meters of the ground surface and therefore groundwater is potentially available for transpiration by vegetation during droughts, when the shallow soil moisture is strongly depleted. The groundwater also provides water to deeper-lying surface water bodies such as streams and wetlands. The water-level records of observation wells provide evidence of these processes for transferring moisture from the groundwater reservoir to the atmosphere. The groundwater reservoir exhibits delayed response to the onset of drought and to the cessation of drought. Compilations of observation well records from across the prairie region provide quantitative evidence of the groundwater response to drought. The records for shallow water-table wells and for deep confined-aquifer wells are consistent and even give an indication that the groundwater response lags behind the soil moisture response, as might be expected.

1C09.4 ID:3388 14:45

Analysis of Real Time Prairie Drought Monitoring and Forecasting System

Lei Wen [1], *Charles Lin* [2], *Zhiyong Wu* [3], *Guihua Lu* [3], *John Pomeroy* [4], *Yufei Zhu* [2]

[1] McGill University
[2] Environment Canada
[3] Hohai University
[4] University of Saskatchewan
Contact: lei.wen@mcgill.ca

A real time drought monitoring and forecasting system was developed, tested and implemented over the Canadian Prairies (1,964,000 km2). The system uses the VIC (Variable Infiltration Capacity) model to simulate daily soil moisture values starting from 1 January, 1950, and continually running through present into the future with a lead time up to 35 days. VIC is driven by daily maximum and minimum air temperature and precipitation from 1,167 meteorological stations for reconstructing and monitoring runs up to the present, and by the operational Canadian GEM (Global Environmental Multiscale) model forecast (0 to 6 days), the operational 40-number super ensemble forecast of Canadian Meteorological Center (CMC; 7 to 15 days), and the operational CMC ensemble seasonal forecast (16 to 35 days) for the forecasting runs. The novel feature of our methodology is the use of both gauge and model data to drive VIC for real time drought forecasting. The simulated soil moisture values are used to calculate the Soil Moisture Anomaly Percentage Index (SMAPI) as an indicator for measuring the severity of agricultural and hydrological droughts. The SMAPI is qualitatively compared with three independent drought datasets, which are the North American Drought Monitor (NADM), the Palmer Drought Index (PDI) of Agriculture and Agri-Food Canada, and the Environment Canada Palmer Drought Severity Index. The result indicates that the SMAPI compares favorably with these datasets. Our VIC prairie soil moisture simulation is updated daily, and the SMAPI results with different temporal scales of daily, monthly, seasonal and annual are publicly accessible online (http://www.meteo.mcgill.ca/~leiwen/vic/prairies/). In contrast to many other real time hydrological modeling, our drought reconstructing, monitoring and forecasting system emphasizes on the idea of maintaining consistency between the real time and long term soil moisture simulations. The examination and interpolation of current model conditions in the context of the model's historical climatology can thus be legitimized through the introduction of SMAPI.

1C09.5 ID:4068 15:00

Drought Research in Western Canada: a Critical Step in Bringing Climate Services to Users

Richard Lawford [1], *Harvey Hill* [2], *Elaine Wheaton* [3], *Phillip Harder* [1], *Ronald Stewart* [1]
[1] University of Manitoba
[2] AAFC
[3] Saskatchewan Research Council
Contact: lawfordr@cc.umanitoba.ca

Many economic activities in western Canada are very vulnerable to drought. Strategies for adapting to water stress on the Canadian prairies have been developed over decades as farming communities and water managers have experienced alternating periods of water surpluses and water deficits. The effectiveness of many of these strategies is dependent on climate predictions and on the information that is known from similar drought events. The Drought Research Initiative (DRI), a 5-year study that has focused on the 1999-2004/05 multiyear drought, has maintained an on-going dialogue with users as it has carried out its research. This presentation describes how information developed by DRI can assist a wide range of users regarding issues such as drought response and the management of water and other natural resources that were identified through the DRI user dialogue. The talk also provides some commentary on the effectiveness of the various techniques used in interacting with users to gain insights about their information requirements.

1C09.6 ID:3568 **15:15**

Extreme Climate Events Preparedness and Adaptation Simulation Exercises: The Case of the Drought Preparedness Partnership (DPP)

Nancy Lee , *Harvey Hill* , *Monica Hadarits*
Agriculture and Agri-Food Canada
Contact: Monica.Hadarits@agr.gc.ca

Drought and other extreme precipitation events are projected to occur with increasing frequency and magnitude because of climate change and variability. Agriculture and Agri-Food Canada (AAFC), along with its partners, is directing its attention towards better preparing Canadian agriculture for such events by enhancing climate adaptation efforts. The Drought Preparedness Partnership (DPP) project is a first step in achieving this goal, with future efforts being directed towards other extreme events affecting agriculture, such as excessive moisture.

The DPP is a framework that aids in the documentation and assessment of past institutional drought initiatives and responses. This is accomplished in a simulation exercise where provincial government representatives discuss and evaluate their organization’s current capacity to respond and adapt to future droughts. These representatives also identify gaps and vulnerabilities in their responses that need to be addressed in order to increase their institutions’ adaptive capacity. This information forms the basis for understanding future drought preparedness and can be used to improve drought planning and adaptation initiatives.

This poster summarizes the findings from DPP pilot projects held in the provinces of Saskatchewan and Manitoba. Preliminary findings indicate that institutions in both provinces are improving in all categories evaluated by participants except resources. Participants generally agreed that more information has become available since the last drought to support decision-making; however, they frequently stressed that there were still large resource gaps for monitoring and improving data availability. There was agreement that more proactive and anticipatory coping strategies are required to alleviate the effects of future droughts on society, agriculture, other economic sectors, and the environment.

Climate change and the carbon cycle (Part 2) / Le cycle du carbone et les changements climatiques (Partie 2)

Room / Endroit (Pinnacle), Chair / Président (Vivek Arora), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C10.1 ID:3707 INVITED/INVITÉ 14:00

Recent trends in the land and ocean CO2 sinks

Corinne Le Quere
University of East Anglia and The British Antarctic Survey
Contact: c.lequere@uea.ac.uk

Only about 45% of the total CO2 emitted from the burning of fossil fuel and from land use changes remain in the atmosphere each year on average. The remaining CO2 emissions are taken up by the natural carbon reservoirs (the “CO2 sinks”) on land and in the ocean. The land and ocean sinks are sensitive to climate and elevated CO2. In the past 50 years, the fraction of CO2 emissions that remained in the atmosphere each year (the 'airborne fraction') has likely increased, from ~40% in the 1960s to ~45% between 2000 and 2008. The uncertainty in the airborne fraction trend estimated from observations is large, but it is supported by models used to estimate the trends in the CO2 sinks over the same time period. The models suggest that the positive trend in airborne fraction was caused by a decrease in the efficiency of both the land and ocean CO2 sinks in response to climate change and variability: The CO2 sinks increased in the models, but not as fast as they did in the absence of changes in climate. In the ocean, changes in winds in the Southern Ocean and equatorial Pacific and surface ocean warming were the main drivers of trends, with important non-linear effects. The model trends are supported by the existing repeated CO2 measurements in the ocean, which show that the CO2 uptake was weaker than expected in the past two decades in the North Atlantic, Southern Ocean and west Equatorial Pacific. Changes in the CO2 sinks are highly uncertain, but they could have a significant influence on future atmospheric CO2 levels. It is therefore crucial to reduce the uncertainties through improved monitoring of the sinks, and better data-model synthesis efforts.

1C10.2 ID:3981 14:30

Nonlinearity of carbon cycle feedbacks

Kirsten Zickfeld [1], *Michael Eby* [2], *Damon Matthews* [3], *Andrew Weaver* [2]
[1] Environment Canada
[2] University of Victoria
[3] Concordia University

Contact: Kirsten.Zickfeld@ec.gc.ca

With a few exceptions, state-of-the-art coupled climate-carbon cycle models project a positive feedback of climate change on atmospheric CO_2 levels. Standard metrics of this feedback assume that the response of land and ocean carbon uptake to CO_2 ("concentration-carbon cycle feedback") and climate change ("climate carbon cycle feedback") combine linearly. Here we explore the linearity in the carbon cycle response systematically by using simulations with an Earth system model of intermediate complexity (the UVic ESCM). Our results indicate that the concentration-carbon and climate-carbon cycle feedback do not combine linearly to the overall feedback. In our model, the carbon sinks on land and in the ocean are less efficient if exposed to the combined effect of elevated CO_2 and climate change, than to the linear combination of the two. On land, this nonlinearity is associated with the different response of vegetation and soil carbon uptake to climate in the presence or absence of the CO_2 fertilization effect. In the ocean, the nonlinear response is caused by the interaction of changes in physical properties and ocean biology with anthropogenic CO_2. These nonlinearities have implications for the estimation of standardly used metrics of carbon cycle feedbacks.

1C10.3 ID:3754 14:45

A proposed framework for avoiding dangerous climate impacts from cumulative carbon emissions

Damon Matthews [1], *Kirsten Zickfeld* [2]
[1] Concordia University
[2] Canadian Centre for Climate Modelling and Analysis
Contact: dmatthew@alcor.concordia.ca

The primary objective of The United Nations Framework Convention on Climate Change is to stabilize greenhouse gas concentrations a level that will avoid dangerous climate impacts. However, greenhouse gas concentration stabilization is not the most appropriate framework within which to assess dangerous climate change on account of the significant lag between a given concentration level, and the eventual equilibrium temperature change. By contrast, recent research has shown that global temperature change can be well described by a given cumulative carbon emissions budget; consequently, cumulative emissions may be a more appropriate framework within which to assess emission targets aimed at avoiding dangerous climate change. Here, we present a new cumulative emissions framework for climate impact assessment. We show first that both carbon dioxide concentration targets at a given year and the associated temperature changes are uniquely associated with a cumulative carbon emissions budget, regardless of the emissions pathway. We show further that it is generally possible to overshoot concentration targets without overshooting the temperature target, but that temperature overshoots may not be possible without technological intervention to achieve negative emissions. It follows also from this analysis that the rate of temperature change can be related to the rate of

increase of cumulative carbon emissions. As a consequence, climate impacts that are sensitive to a given level of global temperature change can be avoided by restricting total cumulative emissions, whereas the rate of emissions cuts over the next century will determine the severity of climate impacts which are sensitive to the rate of global temperature change.

1C10.4 ID:3660 **15:00**

Climate evolution following a complete cessation of carbon dioxide emissions

Nathan Gillett , *Vivek Arora* , *Kirsten Zickfeld*
CCCma, Environment Canada
Contact: nathan.gillett@ec.gc.ca

Several recent studies have highlighted the persistent nature of the climate response to carbon dioxide emissions. We examine several simulations of the the Canadian Centre for Climate Modelling and Analysis (CCCma) first generation Canadian Earth System Model (CanESM1), which consists of full three dimensional coupled ocean and atmosphere models with terrestrial and marine carbon cycle components. A realistic scenario of past and future carbon dioxide emissions is prescribed, but with emissions set to zero after either 2010 or 2100. Consistent with other studies, we find that atmospheric carbon dioxide falls rapidly immediately after a cessation of emissions as carbon is taken up by the land sinks, but after about a century atmospheric carbon dioxide declines only very slowly as the ocean takes up carbon, but the land biosphere gives up carbon. We find that global mean temperature remains almost constant for the remaining 900 years of the simulation following the cessation of emissions. However this constancy of global mean temperature masks strong ongoing regional changes: A cooling of the Northern Hemisphere and a recovery of Arctic sea ice, and an ongoing warming of the Southern Hemisphere and decline in Antarctic sea ice. At the same time, the ocean continues to take up heat, leading to a large committed thermosteric sea level rise and possible increasing contribution to basal melting of Antarctic ice shelves.

Ocean Observatories: Online and Operational / Observatoires océaniques : en ligne et opérationnels

Room / Endroit (Bytowne), Chair / Président (Richard K. Dewey), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C11.1 ID:3554 14:00

The St. Lawrence Global Observatory (SLGO) - an innovative network offering technological solutions

Joanne Hamel
General director - St. Lawrence Global Observatory
Contact: chavignotg@ogsl.ca

Large amounts of data are regularly collected by various organizations carrying out monitoring or research activities on the St. Lawrence ecosystem in response to a common need to better understand, model or predict changes that occur in the environment. However, access to such a wealth of information is often inefficient due to the lack of a common framework that ensures interconnections between organisations, data registries, systems and user interfaces, and the use of recognized standards.

The vision behind the St. Lawrence Global Observatory (SLGO) initiative launched in 2005 is to provide efficient Web access to timely and accurate data and information from a network of federal, provincial, academic and community organizations for the sustainable management of the St. Lawrence ecosystem. The synergy created by clustering the means and expertise of the member organizations results in optimizing information dissemination, reducing duplicated efforts and identifying data gaps. It also helps support planning and decision making processes in areas such as public safety, climate change, resource management and conservation.

This multidisciplinary and innovative approach is based on Web service development in a service-oriented architecture (SOA) and on access to distributed data assets including a broad range of real-time and archived data as well as modelling, forecasting and operational services.

1C11.2 ID:3693 14:15

VENUS in Saanich: An excellent observatory for studying impacts of hypoxia on coastal waters

Frank Whitney [1], *Verena Tunnicliffe* [2], *Richard Dewey* [2], *Gail Anderson* [3]
[1] Fisheries and Oceans Canada
[2] University of Victoria
[3] Simon Fraser University
Contact: whitneyf@shaw.ca

Saanich Inlet is a well studied, annually anoxic fiord on Canada's west coast. The pattern of deep water anoxia and summer renewal of basin waters was described in the 1960s and has been a curiosity for many studies over ensuing decades. However, only with the installation of the VENUS cabled observatory was it obvious how rapidly oxygen levels can vary at mid depths. Seasonally, oxygen varies between a late summer low of 0.1 and a spring high of 4 ml/l at the VENUS depth of 97 m. However, over a fortnightly tidal cycle, oxygen can vary

by >3 ml/l. Such rapid changes create habitat stress which results in a quickly varying biotic community. Forensic studies demonstrate how low oxygen can eliminate some of the large animals needed to initialize the breakdown of a pig carcass, a rather dramatic example of how recycling processes are impacted by oxygen levels.

1C11.3 ID:3386 INVITED/INVITÉ 14:30

Broadband acoustics on the VENUS observatory in Saanich Inlet

Tetjana Ross [1], *Wu-Jung Lee* [2], *Ana Lara Lopez* [3], *Julie Keister* [4], *Charles Greene* [5]
[1] Dalhousie University
[2] WHOI/MIT Joint Program
[3] Scripps Institution of Oceanography
[4] University of Washington
[5] Cornell University
Contact: tetjana@dal.ca

High-frequency acoustic data, each ping rich in information on the whole water column, is ideally suited to long-term deployment on cabled ocean observatories. Long-term acoustic observations allow for the monitoring of the depths and abundances of fish and zooplankton. The drawback is that is it difficult to conclusively identify which species (or even functional groups) are present at any given time. This can be done, but only with plenty of supporting data, generally acquired non-autonomously and at great expense.

Broadband acoustics may be the key to making acoustic observations less qualitative. Here we explore this idea. We present nearly two years (Apr. 2008 to Feb. 2010) of broadband (85-155 kHz) echosounder data collected on the VENUS observatory in Saanich Inlet. Using historical and contemporaneous (July 31, 2009) zooplankton net-tow data, we develop and validate a classification scheme for the scattering layers throughout the long-term record.

1C11.4 ID:3520 14:45

Characteristics of diel vertical migration based on one-year acoustic records in Saanich Inlet

Mei Sato , *John Dower* , *Eric Kunze* , *Richard Dewey*
School of Earth and Ocean Sciences, University of Victoria
Contact: meisato@uvic.ca

Euphausiids play a key role in coastal British Columbia food webs as leading prey items for Pacific hake, spiny dogfish, Pacific herring and Pacific salmon. Diel vertical migration by euphausiids connects deep water and pelagic communities through bidirectional transfer of organic matter and excreted inorganic nutrients. Vertical migration might also play a role in producing turbulence. Here, we explore a one-year continuous record of euphausiid diel vertical migration from a

200-kHz echosounder that is part of the VENUS observatory in Saanich Inlet. The continuous record allows us to examine both diurnal and seasonal variability in the timing of migration, the effect of insolation on deep scattering layers, vertical migration speed, and two-layer migration patterns. The timing of migration corresponds to sunrise and sunset regardless of variations in insolation. Instead, insolation seems to control the depth of deep scattering layer during daytime. The upward migration speed of the scattering layer shows some seasonal pattern, with values of 1.6 – 3.5 cm s^{-1} in fall – winter and a minimum of 0.9 cm s^{-1} in May. This seasonal pattern appears to correspond, at least in part, to the life cycle of *Euphausia pacifica*, the dominant species in Saanich Inlet. Two-layer migration patterns were observed in late December through February, and may also be associated with life cycle demographics. Although its species composition is yet unknown, the appearance of the two-layer migrations corresponds to the timing of herring migration to Strait of Georgia in early November, some are known to go into Saanich Inlet.

1C11.5 ID:3796 15:00

Physical processes in Barkley Canyon via NEPTUNE Canada: First results from a (hopefully) long-term program

Douglas Schillinger , *Alex Hay*
Dalhousie University
Contact: doug.schillinger@dal.ca

Four instrument platforms were deployed in September 2009 at Barkley Canyon west of Vancouver Island on the canyon wall, canyon floor and adjacent shelf, as part of the NEPTUNE Canada Cabled Ocean Observatory. Data from these instrument platforms began to flow in December 2009. Rotary sonars operating at 675 kHz are providing images of the ocean bottom extending to maximum ranges of O(100 m). Upward-looking 150 and 600 kHz Acoustic Doppler Current Profilers on the shelf and canyon wall are providing measurements of the vertical structure of the flow. Laser-scaled pan-tilt video cameras are providing more detailed images of the seafloor at short range. Temperature, salinity and fluorescence near the bed are also being continuously monitored. Preliminary results from the first 6 months of quasi-continuous operation will be presented, focusing on the temporal changes to the seafloor and the spatial variability of the benthic environment between the shelf, canyon wall and canyon axis. The temporal changes in seafloor patterns will be discussed in relation to events in the velocity and fluorescence records, with a view to establishing connections to storm events on the shelf, and to the spring bloom.

1C11.6 ID:4023 15:15

Live data from the coast to the deep sea: NEPTUNE Canada

Mairi Best , *Chris Barnes* , *Brian Bornhold* , *Fern Johnson* , *Benoit Pirenne*
NEPTUNE Canada

Contact: mmrbest@uvic.ca

Data from across the disciplines of Ocean and Earth science are streaming live from the Northeast Pacific, and these data are freely and openly available to the world through the Internet. They are provided by the NEPTUNE Canada regional cabled ocean observatory which spans the northern Juan de Fuca Plate. Most of the initial experiments, planned through workshops and international competitions, were installed at 4 out of the 5 network nodes during the summer of 2009 (inshore Folger Passage (Barkley Sound), Barkley Canyon and upper slope, mid slope ODP 889, and abyssal ODP 1026-7). The fifth node at Endeavour Ridge will be instrumented in 2010. Early results include detection of tsunamis, tracking of phytoplankton blooms to the benthos, and shelf oxygen trends. The infrastructure has capacity to expand and we invite participation in experiments, data analysis, and technology development; for information and opportunities: http://www.neptunecanada.ca.

Building this continuous power and high bandwidth $100M facility over the past decade required integration of hardware, software, and people networks. Hardware developed and installed includes: 800km powered fibre-optic Backbone cable; Nodes and Junction Boxes; mobile platforms including a Vertical Profiler and a seabed Crawler, and scores of Instruments. In parallel, software and hardware systems are acquiring, archiving, and delivering continuous real-time data. A web environment to combine this data access with analysis and visualization, collaborative tools, interoperability, and instrument control is in place and expanding. A network of scientists, computer scientists, engineers, and technicians is contributing to the process in every phase.

NEPTUNE Canada will transform our understanding of biological, chemical, physical, and geological processes across an entire tectonic plate from the shelf to the deep sea (17-2700m). Real-time continuous monitoring, archiving, and long time series allow scientists to capture the temporal nature, characteristics, and linkages of these natural processes in ways never before possible.

On Advanced Geocomputations and Web Collaboration / Calcul informatisé avancé en géomatique et collaboration Web

Room / Endroit (Laurentian), Chair / Président (Rod Blais), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C13.1 ID:4113 INVITED/INVITÉ 14:00

GeoCENS: Geospatial Cyberinfrastructure for Environmental Sensing

Steve Liang [1], *Edward Johnson* [2], *Cathy Valeo* [2], *John Pomeroy* [3], *David Chang* [1], *Rohana Rezel* [1], *Shawn Chen* [1], *Alec C.y. Huang* [1], *Leah R.y. Li* [1], *James Badger* [1], *Jennifer He* [2], *Kevin Hook* [3]
[1] Geomatics Engineering, University of Calgary
[2] Biogeoscience Institute, University of Calgary
[3] Centre for Hydrology, University of Saskatchewan
Contact: blais@ucalgary.ca

In recent years, large-scale sensor arrays and the vast data sets they produce world-wide are being utilized, shared and published by a rising number of researchers on an ever-increasing frequency. The increased amount of available data is being driven by sensor motes which are monitoring changes in everything from climate to water to biological species. With the rapidly increasing number of large-scale sensor network deployments, the vision of a World-Wide Sensor Web (WSW) is becoming a reality. Similar to the World-Wide Web (WWW), which acts essentially as a “World-Wide Computer”, the Sensor Web can be considered as a “World-Wide Sensor” or a “cyberinfrastructure” that instruments and monitors the physical world at temporal and spatial scales that are currently impossible.

The Geospatial Cyberinfrastructure for Environment Sensing (GeoCENS) aims to build an interactive online social network-based platform where scientists can remotely access, share and control geographically dispersed environment sensors and datasets through international sensor web standards. GeoCENS is unique in that (1) GeoCENS is a social network sensor web platform; (2) GeoCENS is a standard-based sensor web platform. GeoCENS is developed based on the OGC sensor web standards (i.e., OGC SWE); and (3) GeoCENS is an intuitive and high performance 3D sensor web browser that combines multiple sensor data sources and geographical datasets, and render them in a coherent and unified virtual globe environment.

In this presentation, we will present GeoCENS. We will firstly introduce the three motivating technologies, namely Web 2.0, Wireless Sensor Networks, and Cyberinfrastructure. Then a detailed architecture of GeoCENS will be explained. Challenges in building such large-scale sensor web system will be presented. The challenges at least include three different levels, i.e., technical, semantic, and institutional challenges. We will demonstrate the GeoCENS prototype system. And finally, future directions and roadmaps will be presented.

1C13.2 ID:3877 14:30

Wavelets for Feature Extraction and Object Recognition from LIDAR Data

Mohamed Elhabiby [1], *Hassan Elhifnawy* [2], *Naser El-Sheimy* [3]
[1] Senior Research Associate
[2] Phd Student
[3] Professor

Contact: mmelhabi@ucalgary.ca

A new computational scheme using the wavelet transform is employed for feature extraction and object recognition from LIDAR data will be introduced. The LIDAR image is approximated in finite multi-resolution analysis subspaces and the wavelet algorithm is built by testing different base function. The technique is used to identify different features by monitoring and localizing the different LIDAR data property changes. Wavelet decomposes image to an approximation and details. The extracted details after the application of the discrete 2-D wavelet transform will help in the identification of the building boundaries based on the fact that there are sudden changes in the LIDAR height values at these boundaries. The object boundary will be used as object representative.

The wavelet multi-resolution will be also used for object recognition through building wavelet coefficient library descriptors to be used in the object recognition from the corresponding different format images. These descriptors are closely correlated with object properties itself, and then it can be considered as high reliable object recognition descriptors. There are many descriptors that can be derived in different domains to describe the representative of object of interest. The descriptors will be derived in the frequency domain as wavelet coefficients descriptors. Continuous Wavelet Transform (CWT) will be applied on the object boundary to derive the corresponding boundary descriptors. A complete evaluation of the use of the different wavelet techniques for both feature extraction and object recognition will be introduced. Conclusions and recommendations are given with respect to the suitability, accuracy, and efficiency of this method.

1C13.3 ID:3499 **14:45**

Simulations of gravimetric terrain corrections using LIDAR data

Rod Blais
University of Calgary
Contact: blais@ucalgary.ca

Terrain corrections for gravity measurements are necessary for most geodetic and geophysical applications of gravity data. The well-known terrain correction integral in terms of the Poisson kernel relies on the topography in the neighborhood of the gravity stations and the crustal density assumptions. Airborne LIDAR provides terrain data with submetre resolution which can be used for quadratures and also for Monte Carlo simulations. Following a brief overview of the common multigrid formulations, Monte Carlo simulation strategies will be discussed for different applications of gravimetric terrain corrections using computer simulations. General conclusions and recommendations about these simulation results will be given along with expected error estimates.

1C13.4 ID:3895 15:00

Real-Time Code Smoothing using Multi-Resolution Analysis

Ahmed El-Ghazouly [1], *Mohamed Elhabiby* [2], *Naser El-Sheimy* [3]
[1] PhD candidate Mobile Multi-sensor Research Group,Geomatics Department , University of Calgary
[2] Senior Research Engineer, Treasure of the Geodesy Section - Canadian Geophysical Union
[3] PEng, CRC. Professor and Canada Research Chair, Geomatics Department , University of Calgary
Contact: aaelghaz@ucalgary.ca

GNSS receivers provide diverse measurements, namely the pseudorange and carrier phase measurements. The change of these measurements between successive epochs is the same, but carrier phase is far more accurate. In the measurement domain techniques like Carrier smoothed Code (CsC) using Hatch Filter or Code Noise and Multipath algorithm (CNMP) are successfully used and considered for implementation in Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) to reduce receiver noise and high rate multipath error. CsC techniques can effectively remove high frequency errors but low frequency errors such as ionosphere and low rate multipath can accumulate a bias at the output of this smoothing.

In this paper a new multi-resolution approach based on wavelet de-trending technique is introduced to isolate medium to high frequency errors i.e. multipath and noise from the ionosphere divergence. The new technique operates on the Code minus Carrier (CmC) observables in real-time mode using an adaptive wavelet analysis procedure. Given that the ionosphere divergence has a low frequency pattern; wavelet transform approach is used to isolated ionosphere divergence from CmC measurement at the low level of decomposition leaving the high to medium frequency errors at the high levels of decomposition. The separated wavelet coefficients (approximation) are removed using wavelet thresholding technique. The truncation of the approximation coefficients from a specific level of decomposition, based on the ionosphere divergence rate, leaves the high to medium errors in the details part. Finally, the medium to high frequency code measurements errors are estimated by reconstructing the details coefficients. These estimated errors are directly applied to the code phase measurements in real-time scenario leading to smoothed code measurement. The performance of the proposed wavelet technique is assessed experimentally on single frequency receivers. This paper also includes a regressive comparison with various CmC techniques supported by experimental results.

Recent developments in airborne geophysics (Part 2) / Nouveautés en géophysique aérienne (Partie 2)

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Claire Samson), Date (01/06/2010), Time / Heure (14:00 - 15:30)

1C14.1 ID:3992 **14:00**

The AirMt passive airborne EM system

Vlad Kaminski [1], *Petr Kuzmin* [2], *Jean Legault* [1]
[1] Geotech Ltd.
[2] Geo Equipment Ltd.
Contact: jean@geotech.ca

The AirMt (airborne magnetic tensor) passive EM system is the new state of the art technology developed by Geotech Ltd. (Aurora, ON, Canada) that is designed for deep electromagnetic (magneto-variational) airborne prospecting and mapping. It is the third generation of passive source airborne EM system developed by Geotech since 2005 (Kuzmin et al., 2005), following the ZTEM (Z-axis tipper electromagnetic) system (Lo and Zang, 2008), which has been successfully used for commercial mining and geothermal applications since 2007. AirMt source fields are the distant EM fields from sferic electrical storm activity, identical to those used in audio-magnetotellurics and AFMAG (Ward, 1959). Its advantage over ZTEM is the capability to measure three orthogonal components of primary and secondary magnetic field (Hx, Hy and Hz), as opposed to a single vertical component measurement. The three measured components are further converted into a attitude-invariant total field tensor parameter “Ht”, which is sensitive to electrical properties of the geological targets and tectonic disruptions.

The major practical benefit of the total field measurement approach is the absence of Hx-Hy-Hz component separation through tilt-compensation, which significantly improves signal to noise, permits a more compact design, simplifies the data acquisition & processing and allows the system to be utilized more freely in mountainous terrains. Just as ZTEM data have been uniquely inverted for electrical properties for a 2D generalized earth model using a-priorie constraints (Legault et al, 2009), a similar 2D interpretation tool will provide additional proof of concept for the method. In addition to test flights comparing the AirMt system against ZTEM and VTEM (Witherly et al., 2004), a commercial survey example flown with AirMt in Nevada showcases the system capability to differentiate between rock types in a porphyry copper environment, which makes the system suitable for mining and geothermal, and potentially oil and gas applications.

1C14.2 ID:4017 **14:15**

Gravity and Magnetic Modeling using Monte Carlo Method on unstructured grid

Nacim Foudil-Bey [1], *Li Zhen Cheng* [1], *Jean-Jacques Royer* [2], *Guillaume Caumon* [2]

[1] UQAT, Canada
[2] CRPG, France
Contact: li_zhen.cheng@uqat.ca

Tetrahedral grids provide accuracy tool for modeling heterogeneous complex geological structures. This approach requires fewer elements to be calculated as compared to conventional prismatic one. This work aims to present some examples of 3D forward modeling comparison between different classical approach (prismatic, polyhedral) with new tetrahedral technique. For the gravity field calculation, each elementary tetrahedral cell is reduced to a single mass point at its center. For the magnetic components, the elementary tetrahedral cell is assumed to a magnetic dipole. This new method is well adapted for airborne survey particularly when the distance between the observed point and the tetrahedron's center is much larger than the distance between the center of the tetrahedron and its cell vertex. In order to obtain more accurate results, the near surface coarse cells are subdivided into smaller tetrahedral cells. This process is performed recursively for each new tetrahedron as long as the previous distance condition is not respected.

Stochastic inversion modeling is implemented based on the Monte Carlo method in order to simulate 3D densities and/or magnetic susceptibility distribution of the possible models. This method combines prior information with observed data to determine the posterior probability of the models.

1C14.3 ID:4024 **14:30**

Lineament analysis as a tool for hydrocarbon and mineral exploration: a Canadian case study

Madeline Lee , *Bill Morris*
McMaster University
Contact: leemd@mcmaster.ca

An understanding of the geological framework and localized structural constraints are critical to hydrocarbon and mineral deposit exploration. As such, lineament tectonics has been used successfully to delineate oil and ore deposits around the world. Lineament analysis is completed on various geoscientific data: aerial photography, topography, and geophysics. There are various approaches to extract lineament information. While a visual approach is most common; the method is subjective and time consuming especially when applied to large data sets. Therefore, automated routines are important to promote efficiency. Within geophysics, possible numerical approaches include source edge detection routines and the Hough transform. We suggest an alternative approach, which is to implement a methodology commonly applied to topographic data – “stream flow analysis”. Stream flow analysis delineates stream locations, flow impact, and flow direction by identifying localized low points and their continuity on a topographic surface. In this study, we apply stream flow analysis to a “topographic” surface defined by aeromagnetic data, where faults and fractures are revealed since they are represented by magnetic lows. Conversely, magnetically high features, such as dykes, are delineated by changing the data set background value causing highs to be represented by lows. Furthermore, by constraining the dimensions of the “catchment area” we are able to isolate linear features at multiple scales. Further analysis of stream segments involves direction /length studies, linearity analysis, and stream intersection points. Typically, geologic terranes will have a dominant fabric or fracture orientation due to the local tectonic history. Therefore if the linear directions are isolated along specific orientations, different geologic terranes are resolved. Ore deposits will commonly occur along fracture systems since they act as a conduit for hydrothermal fluids. When multiple fractures culminate at a common intersection, the probability of occurrence increases. Thus, visualization of ‘stream intersection’ points in conjunction with geophysical grids will highlight key potential areas. These methodologies are applied to a study area in the Northwest Territories, Canada which has been shown to have high mineral potential and similar IOCG-type deposits as Olympic Dam in Australia.

1C14.4 ID:4076 14:45

The Concept and Development of a Truly Flexible HTEM System

Jonathan Rudd
Aeroquest Surveys
Contact: jrudd@aeroquest.ca

Since the introduction of the first commercial HTEM system in 1998, several helicopter time-domain electromagnetic (HTEM) technologies have been established and are maturing to the point where now, HTEM dominates the field of airborne electromagnetic surveying. The principal features of the AeroTEM system, the first to be commercialized, are a rigid frame which houses both the transmitter and the receivers, full waveform data capture, multi-component receivers, and low-noise recording of both on-time and off-time decays.

Much of the development focus in the HTEM industry has been on the strength of the transmitted signal with the goal of maximizing the depth of exploration. Ongoing development at Aeroquest has produced the next generation of AeroTEM systems which replaces most of the analog components of the system with a modular networked system. This system retains all of the principal AeroTEM features, and adds digital waveform generation and sensor-level digitization of the signal. The transmitted waveform is defined and produced through on-board digital signal processing (DSP) software with full control over the waveform type, pulse width, and amplitude. The monitoring and control is performed at a high rate (approximately 200 kHz). The receiver electronics are controlled by the same DSP as the transmitter which results in well-synchronized, highly sampled data. This dense digitizing rate makes it possible to minimize and/or remove the effects from high-frequency noise sources (Gibbs effect, spherics, etc…) in real-time or during post-processing, and improves the quality of the early-time data. Future research and development will focus on active monitoring of the waveform to allow for compensation of thermally-induced drift, waveform asymmetry and power supply variations. The principal goal and benefit of this development is in the interpretation of the data. Well-calibrated, low-noise data facilitate more accurate and ultimately more useful interpretations by way of the rigorous inversion codes available today.

1C14.5 ID:4087 15:00

A Simple Adaptable Data Fusion Methodology for Geophysical Exploration

George Leblanc [1], *William Morris* [2]
[1] National Research Council Canada
[2] McMaster University
Contact: george.leblanc@nrc-cnrc.gc.ca

Data fusion is a term that typically has had a wide degree of variability in definition, rigour and application. For exploration geophysics, at one end of this spectrum, data fusion techniques are often used to describe nothing more than the overlaying of map sheets, which is the simplest and quickest process to do, but has provided a good deal of real-world results. At the other end of the spectrum there exists extremely elegant and complex methods for fusing data in mathematical sub-spaces that define the characteristics of the data well, yet are extremely difficult to implement in a practical environment. In this presentation, we will show an adaptable methodology that is highly applicable to exploration geophysics, simple to implement using conventional analysis tools and is a true data fusion technique. Our method primarily relies on the ability of the operator to understand the nature of the individual data sets within the specific exploration environment of interest. Based on this knowledge the individual datasets are fused via our methodology to produce a new product that provides confidence locations of the intended targets. Through example, by using aeromagnetic and airborne radiometric data collected over the Hemlo gold deposit, we show that our method provides a simple to use and understand technique to acquire a wealth of information that goes beyond the simple overlaying of maps.

1C14.6 ID:4097 15:15

Continuing developments of SkyTEM

Flemming Efferso [1], *Max Halkjaer* [1], *Kurt Sorensen* [2], *Rolf Pedersen* [1]
[1] SkyTEM ApS
[2] Aarhus University
Contact: norcanex@sympatico.ca

SkyTEM is a helicopter-borne time-domain electromagnetic system designed and developed at Aarhus University, Denmark. Since the first commercial surveys in 2003 the system has been a subject of ongoing R&D. During the years it has been essential to not compromise the high data accuracy. Steps taken to improve data quality will be presented.

Initial surveys focused on locating groundwater aquifers and assessing their vulnerability to both natural and human events. It was recognized that the cost-efficiency of airborne surveys would only be worthwhile if the resulting resolution was comparable to ground surveys. To obtain the needed high vertical resolution it is essential to record unbiased data and to have a very fast transmitter turn off.

The solution was the development of the patented dual-moment transmitter system which allows for bias-free data recorded from gate centre times earlier than 10 µsec. The gate centre times are measured from the start of turn off. With the dual-moment there is no need to compromise between achieving high resolution with the low moment and the depth penetration obtained via the high moment.

A sharp turn-off ramp enhances the ability to resolve the near-surface layers. Also a sharper turn off will increase the resolution of more resistive geology. When using a system where bias correction and leveling is not required the recorded data is available to the client immediately after the helicopter lands. To ensure that all the details in the high quality data will be modeled correctly SkyTEM ApS has developed a real-time robust inversion scheme to be able to provide the best foundation for the client to make quick decisions.

A system initially developed to assess more precisely groundwater aquifers is applicable to other objectives. This became evident when surveys were carried out with objectives such as mineral exploration, oil and gas exploration, geotechnical investigations and landslide risks.

The presentation will elaborate on these topics with focus on the resulting improvements of the SkyTEM system.

POSTER General Atmospheric Sciences / AFFICHE Séance générale sur les sciences atmosphériques

Room / Endroit (Terrace / Terrasse), Chair / Président (D.M. Whelpdale), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0201.1 ID:3711 16:00

Canadian Spherical projector for the Presentation of Environmental Data (CASP-ED)

James Drummond , *Thomas Duck* , *Randall Martin* , *Jeffrey Pierce*
Dalhousie University
Contact: james.drummond@dal.ca

There are major challenges to communicating the results of global environmental data to various audiences. Two of the problems are the amount of data to be presented and the fact that the natural location of the data is on a sphere whereas most display systems are inherently 2-dimensional. The Canadian Spherical Projector for the Presentation of Environmental Data (CASP-ED) initiative is a new communication tool for Canada – a spherical projection system that can be used to visualize global data on a large sphere with animation.

The CASP-ED data image can be animated and manipulated in real time to provide an even more interactive experience and the observer can actually walk around the large illuminated sphere to gain a further perspective on the information.

This tool can be used effectively not only for research, but also for the communication of results to the general public because it is graphic and dramatic. It affords a method of “taking the data to the people” instead of the other way around.

This presentation will provide an introduction to the CASP-ED system and its capabilities.

CASP-ED is supported by the Canadian Foundation for Climate and Atmospheric Science and the Department of Physics and Atmospheric Science of Dalhousie University.

1P30-0201.2 ID:3778 16:00

Low Level Wind Shear at Pearson Airport

Yi (emily) Zhou [1], *George Isaac* [2], *Peter Taylor* [1]
[1] Graduate Program in Earth and Space Science, York University, Toronto, Ontario
[2] Environment Canada, Cloud Physics and Severe Weather Research Section, Toronto, Ontario,
Contact: yi_zhou01@yahoo.ca

Low level wind shear ($\partial \underline{U}/\partial z$, where $\underline{U}$ is horizontal wind) forecasts from various weather prediction models (GEM-15, GEM-2.5 LAM and RUC-13) as well as the observed surface wind data and AMDAR (Aircraft Meteorological Data Reports) wind profile data has been analyzed for Pearson Airport. Observed and modeled low level wind shear cases and their frequency distribution have been studied. For low level wind shear forecasting within 500 feet and 1000 feet above ground level, GEM-15 Regional has the best capability, the second is GEM-2.5 LAM. For forecasting wind shear within 1500 feet above ground level, RUC is the best one, the second and third are GEM-15 Regional and GEM-2.5 LAM. However, low level wind shears predicted from models are lower than those observed.

1P30-0201.3 ID:3589 16:00

L'utilisation des radars météorologiques dans la production de l'analyse canadienne des précipitations (CaPA).

Guy Roy , *Vincent Fortin* , *Viateur Turcotte*
Environnement Canada
Contact: guy.roy@ec.gc.ca

Le projet CaPA a pour objectif de produire en temps réel une analyse des quantités de précipitations sur une période de 6 heures pour l'Amérique du Nord à une résolution de 15 km. La technique utilisée pour produire l'analyse est basée sur l'interpolation optimale et utilise les prévisions à court terme du modèle régional du Centre météorologique canadien (CMC) comme champ d'essai, les mesures pluviométriques du réseau synoptique et du réseau météorologique coopératif du Québec (RMCQ) ainsi que les taux de précipitations provenant des radars météorologiques. Puisque les mesures de réflectivité comportent trop d'artefacts pour être transformées directement en quantités de précipitations (QPE), un post-traitement doit être effectué afin d'éliminer une bonne partie des échos indésirables. Cette affiche présente la méthodologie utilisée pour réduire au maximum les faux échos, corriger le biais de chacun des radars, fabriquer une mosaïque radar calibrée et soumettre cette dernière au système de production de l'analyse de précipitations. Des scores de vérification sont aussi présentés pour évaluer la qualité de l'analyse de précipitations ainsi produite.

1P30-0201.4 ID:3513 16:00

Nowcasting precipitation onset in Vancouver using CORALNet-UBC lidar imagery

Annie Seagram [1], *Ian Mckendry* [2]
[1] UBC, Honours Environmental Sciences
[2] University of British Columbia
Contact: afseagram14@yahoo.ca

In recent years, the application of ground-based lidar to atmospheric observation and monitoring has become increasingly common. Lidars are unique in that they provide otherwise continuous, high resolution data. However, lidar output has never been used in real-time as a forecasting tool. At the UBC (University of British Columbia) CORALNet (Canadian Observational Research Aerosol Lidar Network) site, an interesting cloud signature is observable on numerous daily plots from the1064/532 nm lidar imagery. The signature features a general downward sloping of cloud cover, ending in a precipitation event (marked by lidar shutoff by rain sensor). These signatures are unique in their shape, slope, and

rate of decline (from first appearance to onset of precipitation). The focus of this study was to determine the synoptic-scale features that resulted in the signatures, and which other meteorological factors influenced the characteristic shape/rate of lowering. With the results, a conceptual model (decision tree) was created to aid in nowcasting precipitation. It is hoped that the results of this study may be used to nowcast with greater accuracy, and to serve as a precursor to automated methods that may exploit quantitative data as forecasting products.

1P30-0201.5 ID:3979 16:00

Spatial trends in weather warning performance leading to improvements in forecasts

Jim Goosen , *Chris Emond* , *Brad Snyder*
Meteorological Service of Canada
Contact: brad.snyder@ec.gc.ca

In 2006 a seven year study of weather warning performance was carried out in Pacific and Yukon Region. This work uncovered a number of temporal and spatial trends in performance. Areas where performance was poor were noted and this helped set the direction for future training endeavours. A subsequent study of three years of data was performed for BC Interior and Yukon in 2010.

The objectives of the latest study were twofold: primarily, to determine whether improvements were made in areas of poor warning performance; and to a lesser degree, assess the impact of training on improving performance in these areas. Included in this analysis, a comparison was made between the quality of prediction centre warnings and that of Scribe (automated) forecasts in warning situations.

Results from this study revealed an improvement in rain and snowfall warning performance for most of the regions identified. We speculate that increased training efforts were responsible for some of this improvement. Comparing prediction centre and Scribe performance revealed a seasonal pattern such that the automated system performed better for rain and worse for snowfall warnings

1P30-0201.6 ID:3322 16:00

Using SAR winds to assess the performance of the GEM LAM2.5

Chris Fogarty [1], *Laurie Neil* [2], *Garry Pearson* [1], *Vladimir Zabeline* [3]
[1] National Lab for Marine and Coastal Meteorology
[2] National Lab for Coastal and Mountain Meteorology
[3] Canadian Ice Service
Contact: chris.fogarty@ec.gc.ca

Detailed wind fields over the ocean observed by synthetic aperture radar (SAR) have been studied and compared with numerical output of surface winds from the Meteorological Service of Canada’s GEM LAM2.5 mesoscale model. Wind fields generated using SAR backscatter from wavelets on the ocean surface show the very detailed nature of wind patterns in the marine boundary layer, particularly in the vicinity of coastlines. Similar features have been observed in output from the GEM LAM over the past two years over Atlantic Canada. In this presentation several examples comparing SAR with model output winds and other imagery will be shown and discussed. Verification of the SAR-based winds compared with surface wind observations will also be shown to develop confidence in the product as a forecasting tool. This work is part of the National SAR Winds Project with a mandate to establish the framework necessary for future "operationalization" of SAR winds for weather forecasting in Canada (primarily from the Canadian Space Agency's RadarSat platforms).

1P30-0201.7 ID:3892 16:00

The SPOOKI post production system

Maryse Beauchemin , *Marc Klasa* , *Sébastien Fortier* , *François Fortin* , *Guylaine Hardy* , *Luc Pelletier* , *Sandrine Edouard* , *Benoit Archambault* , *Hatem Yazidi*
SMC - Centre meteorologique canadien
Contact: maryse.beauchemin@ec.gc.ca

The Canadian Meteorological Centre (CMC) delivers a large number of numerical weather prediction products to the various weather offices and clients throughout Canada and abroad. The current post production system was built according to the needs and ideology of the 1980's and it is becoming obsolete with time. Its cumbersome architecture is difficult to maintain and requires a lot of human and computing resources. The "Weather Elements" section of CMC is aware of the problems associated with its maintenance in the long term and has therefore decided to review in depth the whole approach to the operational post production. The analysis of present and future needs have led to the development of an innovative concept in the operational production field inspired by the "Plug and Play" process. SPOOKI (Système de Production Orienté-Objet contennant une Kyrielle d'Informations – Object oriented production system containing a myriad of information) was created in its present form in 2007. It is based on a modular approach where each plug-in component is specialized, reusable and autonomous. These object oriented programming characteristics greatly simplify the maintenance of the system. Particular attention was also given to create a user-friendly system for novice users. An experimental version of SPOOKI is currently running in development mode and an operational one is planned to be implemented in the coming year. The poster presentation will describe SPOOKI, the future CMC operational post production system. Several examples of usage will be shown.

1P30-0201.8 ID:3831 16:00

The Joint Meteorological Centre – a DND/CF and Environment Canada Initiative

Clarke Bedford [1], *Mario Ouellet* [2]

[1] DND
[2] EC
Contact: clarke.bedford@forces.gc.ca

The Canadian Forces (CF) are required to be able to sustain a number of global deployed operations concurrently as well as the defence of Canada and North America. Weather and oceanographic services are essential to successful military operations. The new Joint Meteorological Centre at CFB Gagetown, NB will create a new team to meet changing and growing military requirements in the 21st century, while making the best use of modern network technologies and numerical weather prediction. The new weather support team will consist of CF Meteorological Technicians and Environment Canada (EC) meteorologists, supported by EC computer science specialists.

This poster will provide an overview of new and emerging military weather support requirements, as well as an understanding of the plan to reach the full operational capability of the Joint Met Centre in late 2012.

1P30-0201.9 ID:3547 16:00

FogDex – A radiation fog forecasting tool

Lindsay Sutton
Meteorological Service of Canada
Contact: david.whittle@ec.gc.ca

The impacts of fog on aviation can be crippling. In particular, radiation fog, one of the most common types of fog in Canada, has the potential to cause near-zero visibilities at aerodromes and halt the flow of air traffic. FogDex was created in order to assist the forecaster in more accurately predicting the onset and dissipation of radiation fog.

Using model GRIB data and GrADS as a processing engine, FogDex systematically mimics the typical procedure of a forecaster analyzing the potential for radiation fog. It produces a map of the probability of radiation fog by weighing four physical factors which favor its formation: light surface winds, abundant boundary layer humidity, clear skies, and the presence of a surface based inversion. Values range from zero to one, with zero indicating a very low probability, and one a high probability, of radiation fog formation.

FogDex renders high resolution graphical output four times daily based on the GEM Regional model output. These images run out to 42 hours, cover all of Canada, and are available via a web site for forecast operations in the Canadian Meteorological Aviation Centre (CMAC) and the Prairie and Arctic Storm Prediction Centre (PASPC).

First developed as a prototype by Anke Kelker (U of A Industrial Internship Program 2001), FogDex has been enhanced by changing the input from BUFR soundings to model GRIB data, giving FogDex better spatial resolution. In addition, detailed verification has been done between the FogDex forecasts and fog occurrence at METAR sites in order to calibrate the weighting of the factors used in the FogDex formulation. This has led to a particular combination being chosen that optimizes the overall performance of FogDex as measured by standard verification indices. Continuing data collection will allow further verification and refinement of FogDex in the future.

POSTER The upper troposphere and lower stratosphere (UTLS) / AFFICHE Haute troposphère et basse stratosphère (HTBS)

Room / Endroit (Terrace / Terrasse), Chair / Président (Michel Bourqui), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0204.1 ID:3704 16:00

Static Stability in the Global Upper Troposphere and Lower Stratosphere: Observations of Long-term Mean Structure and Variability using GPS Radio Occultation Data

Kevin Grise , *David Thompson* , *Thomas Birner*
(Presented by *Thomas Birner*)
Department of Atmospheric Science, Colorado State University
Contact: thomas@atmos.colostate.edu

Static stability is a fundamental dynamical quantity that measures the vertical temperature stratification of the atmosphere. The long-term mean static stability field is characterized by the well-known transition from low values in the troposphere to high values in the stratosphere. However, the magnitude and structure of fine-scale static stability features near the tropopause are difficult to discern in temperature data with low vertical resolution. In this study, the authors apply over six years of high vertical resolution Global Positioning System radio occultation temperature profiles to document the long-term mean structure and variability of static stability in the global upper troposphere and lower stratosphere (UTLS).

The results of this study demonstrate that a shallow but pronounced maximum in static stability exists just above the tropopause at all latitudes (i.e., the “tropopause inversion layer,” or TIL). This study also uncovers two novel aspects of static stability in the global UTLS. In the tropical lower stratosphere, the results reveal a unique vertically and horizontally varying static stability structure, with

maxima located at ~17 km and ~19 km. The upper feature peaks during the NH cold season and has its largest magnitude between 10 and 15 degrees latitude in both hemispheres; the lower feature exhibits a weaker seasonal cycle and is centered at the Equator. The results also demonstrate that the strength of the TIL is closely tied to stratospheric dynamic variability. The magnitude of the TIL is enhanced following sudden stratospheric warmings in the polar regions and the easterly phase of the quasi-biennial oscillation in the tropics.

1P30-0204.2   ID:3730   16:00

Atmospheric Measurements with the Global Positioning System

Panagiotis Vergados , *Spiros Pagiatakis*
York University
Contact: vergados@yorku.ca

Of particular interest in this contribution is the use of the Global Positioning System (GPS) in probing the Earth's atmosphere via radio occultation (RO) measurements. This technique involves tracking dual-frequency GPS radiowave signals through the Earth's ionosphere and neutral atmosphere using Low Earth Orbiters (LEO). Measuring the signal bending, vertical profiles of refractivity containing detailed information of the thermal structure of the Earth's atmosphere from the ground up to 50-60 km can be determined.

A GPS RO processing software has been developed at York University, the results of which are compared against independent measurements from the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC). This research focuses on: (1) introducing the benefits of the GPS RO technique in atmospheric sciences and (2) presenting the step-by-step process of GPS RO observables to atmospheric temperature profiles. Throughout this process, we will also present a series of sensitivity studies in an effort to illustrate the impact of atmospheric refractivity, and essentially of GPS observables, on the accuracy of temperature profiles.

POSTER August 20th 2009 Ontario Tornado Outbreak / AFFICHE Éruption de tornades du 20 août 2009 en Ontario

Room / Endroit (Terrace / Terrasse), Chair / Président (Arnold Ashton), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0208.1   ID:3300   16:00

On forecasting weak and severe tornadoes in Ontario

G.w. Reuter , *T. Prozny*
University of Alberta
Contact: gerhard.reuter@ualberta.ca

Can observed sounding parameters used to help distinguish between thunderstorms with severe and weak tornadoes for southwest Ontario? We analyzed 80 tornadoes occurring downwind of the Buffalo soundings and computed vertical wind shear, convective available potential energy, bulk Richardson number, precipitable water, and storm convergence. There was no evidence of statistical skill to distinguish between strong and weak tornadoes based on these observed sounding parameters, with the exception of precipitable water. Strong tornadoes tended to occur when the atmosphere was unusually humid. The findings will be compared with Alberta tornadoes.

POSTER Stratospheric Processes and their Role in Climate / AFFICHE Les processus stratosphériques et leur incidence sur le climat

Room / Endroit (Terrace / Terrasse), Chair / Président (N. McFarlane), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0301.1 ID:3528 16:00

Middle atmospheric structure of the Arctic 2006 Stratospheric Sudden Warming event

Shuzhan Ren
department of physics, university of toronto
Contact: shuzhan.ren@ec.gc.ca

The Arctic major stratospheric sudden warming (SSW) observed during the 2006 winter was one of the strongest and most prolonged SSW s on record. During the warming not only the stratosphere but also the mesosphere experienced dramatic changes, with the stratopaus e height varying by as much as 30km. Previous work has shown that the mesospheric analysis can be improved, even without mesospher ic observations, through the propagation of information during forecasts by vertically propagating waves. In this work, the CMAM-D AS is used to assess the added benefit of assimilating mesospheric temperature measurements from SABER on mesospheric analyses by c omparing to control

cycles without mesospheric observations. Furthermore, the role of parameterized gravity wave drag (GWD) in dri ving the mesospheric cooling is also assessed. During the SSW the rapid change of zonal mean wind significantly changes the spectr um of vertically propagating gravity waves which are able to reach the mesosphere, thus causing the mesospheric cooling. In Ren et al. (2008), the parameterized gravity wave drag due to subgrid scale waves was found to control the amplitude and depth of the mes ospheric cooling for the 2002 southern hemispheric SSW event. However observations were insufficient to validate this model behavi our. Here, by comparing against mesospheric temperature observations, the behaviour of the GWD scheme during this event is assess ed.

1P30-0301.2 ID:3706 **16:00**

The ACE-FTS Climatological Data set and its role in model assessment

Ashley Jones [1], *Kaley A. Walker* [1], *Jianjun Jin* [2], *Jeffrey R. Taylor* [3], *Chris D. Boone* [4], *Peter F. Bernath* [5], *Gloria L. Manney* [2], *Susan Strahan* [6]

[1] Department of Physics, University of Toronto
[2] Jet Propulsion Laboratory
[3] National Center for Atmospheric Research
[4] Deaprtment of Chemistry, Universtiy of Waterloo
[5] Department of Chemistry, Universtiy of York, York, UK
[6] Goddard Earth Science and Technology Center, University of Maryland, Baltimore County
Contact: kwalker@atmosp.physics.utoronto.ca

The Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS) aboard the Canadian satellite SCISAT (launched in August 2003) was designed to investigate the composition of the upper troposphere, stratosphere, and mesosphere. ACE-FTS utilises solar occultation to measure temperature and pressure as well as vertical profiles of over thirty different chemical species including; O3, H2O, CH4, N2O, CO, NO, NO2, N2O5, HNO3, HCl, ClONO2, CFC-11, CFC-12, and HF. Global coverage for each species is obtained approximately over one year and with a vertical resolution of typically 3-4 km. A quality-controlled climatology has been created for each of these 14 baseline species, where individual profiles are averaged over the period of 2004-2009. Measurements used are from the ACE-FTS version 2.2 data set including updates for O3 and N2O5. The climatological fields are provided on a monthly and a three monthly combined basis (DJF, MAM, JJA, SON) at 5 degree latitude and equivalent latitude spacing and on 33 pressure surfaces (31 of which are defined by the Stratospheric Processes And their Role in Climate (SPARC) Chemistry-Climate Model Validation Activity (CCMVal)). The equivalent latitudes are derived from the GEOS-5 analyses interpolated to the time and location of each ACE occultation. As an example of how the climatology data can be used, we present some preliminary results concerning the behaviour of some key species in the upper troposphere/lower stratosphere and Arctic regions. The ACE-FTS climatological data products will be made freely available on the ACE website.

1P30-0301.3 ID:3804 16:00

The Impact of Surface Temperature Variability on the Climate Change Response in the NH Polar Vortex

Barbara Winter , *Michel Bourqui*
McGill University
Contact: barbara.winter@mail.mcgill.ca

The impact of increasing atmospheric CO2 concentrations on the Brewer-Dobson Circulation, and thus on the temperature and winds of the high-latitude stratosphere, depends strongly on the surface temperature of the control climate. Using a middle-atmosphere chemistry-climate model (the IGCM-FASTOC), we present results from five CO2-doubling experiments run for 100 years (timeslice) each, with different combinations of sea and land surface temperatures: interactively generated by a coupled mixed-layer ocean and/or soil scheme, prescribed interannually varying, or prescribed fixed. The prescribed fields are taken from the fully interactive run from the model in both control and doubled-CO2 mode, and the surface temperature fields in all pairs of experiments are therefore very similar by design. However, they lead to different basic states of the atmosphere, which then respond in very different ways to CO2 forcing. When the sea surface temperature has no interannual variability, there is no significant dynamic climate change response in the polar stratosphere, regardless of land-surface temperature variability. A strong climate-change response in the stratosphere is seen only when sea surface temperatures vary at least interannually and land surface temperatures vary on daily timescales.

1P30-0301.4 ID:3875 16:00

Springtime Arctic measurements of trace gases from 1999 to 2003 at Eureka, Canada - Comparisons with results from Canadian Middle Atmosphere Model

Ellie Farahani [1], *Kimberly Strong* [1], *Theodore Shepherd* [1], *Richard Mittermeier* [2], *Hans Fast* [2]
(Presented by *Elham Farahani*)
[1] University of Toronto
[2] Meteorological Service of Canada
Contact: elham@atmosp.physics.utoronto.ca

Ground-based measurements of ozone and other key trace gases (N2O, CH4, HNO3, NO2, NOx, and partial NOy) are reported for four Arctic springs in the period of 1999-2003. These measurements were made by a UV-visible spectrometer (UT-GBS) and an infrared Fourier transform spectrometer (FTS) at Eureka, Canada (80.05 N, 86.42 W). Climatological chemical fields from the Canadian Middle Atmosphere Model (CMAM), a free-running General Circulation Model, were assessed by comparison with an extended observational data set for the first time.

For the warm Arctic winters, the measured and the CMAM O3 columns agreed to better than 5%, while the CMAM NO2 twilight columns were the same as those from the UT-GBS within measurement errors. The normalized probability density functions (PDFs) of model and measurements were in agreement for O3 and nitrogen species. Based on these distributions, CMAM represents FTS observations well during 1999–2003 at Eureka.

1P30-0301.5 ID:3684 16:00

The extended CMAM: Latest developments.

Stephen Beagley [1], *Victor Fomichev* [1], *Linda Megner* [2], *Kirill Semeniuk* [1], *Mcconnell Jack* [1]
[1] York University
[2] Canadian Space Agency
Contact: beagley@nimbus.yorku.ca

The extended CMAM is a vertically extended version of the Canadian Middle Atmosphere model with a top at about 220 km. Currently this model includes partly interactive neutral and ion chemistry and continues to evolve. Several developments are underway to make this ground to thermosphere GCM a more complete tool. Firstly the interactive nature of the model has been expanded into the thermosphere with CO2, and O being interactive between chemistry and radiation in the upper model domain. Secondly a new dynamical version of the extended CMAM is being ported to be used with the CAMDAS setup to allow a 'forecast/assimilation' capability for the CMAM model into the MLT. In addition a number of model improvements are underway including: an upgrade of the model photolysis in line with the regular CMAM and to provide a better MLT simulation, modified aqueous water handling in the middle atmosphere, solar-variability adaptations to allow the Extended CMAM to simulate the solar cycle, transport changes to try and better simulate mesopause and the large fluxes of important chemical species in this region of the atmosphere and their impacts on the middle and upper atmosphere. Results from a series of developmental experiments will be presented.

1P30-0301.6 ID:3593 16:00

Observability of equatorial stratospheric winds

Yulia Nezlin [1], *Matt Reszka* [2], *Yves Rochon* [2], *Shuzhan Ren* [1], *Theodore Shepherd* [1]
[1] University of Toronto
[2] Environment Canada
Contact: yulia.nezlin@gmail.com

The analysis of equatorial winds in the stratosphere faces an objective problem. The problem is in a principal inability of a Data Assimilation to analyze equatorial winds without wind measurements, which is called observability problem. This

work attempts to quantify the observability of equatorial stratospheric winds throuh Observing System Simulation Experiments (OSSE) with a perfect model. The results of OSSEs with two different Data Assimilation Systems (CMAM-DAS and GEM-BACH) will be presented and compared with estimated wind biases between ECMWF and NCEP analyses.

1P30-0301.7 ID:3985 **16:00**

Quality of Reanalysis Data during Extreme Stratospheric Events

Patrick Martineau , *Seok-Woo Son*
McGill University
Contact: patrick.martineau2@mail.mcgill.ca

The quality of reanalysis data in polar climate variability in the stratosphere and upper troposphere is examined by means of comparison with observations and inter-comparison among various reanalysis data. Comparison is made using polar-cap averaged fields for the Northern Hemisphere winter with emphasis on events with great stratospheric intraseasonal variability such as the Stratospheric Sudden Warming (SSW) and Vortex Intensification (VI). Observational data used in the study consists of temperature and height fields derived from the COSMIC/FORMOSAT-3 GPS RO observations for 2006-2009. They are compared with the NCEP/NCAR and ERA-Interim. Inter-comparison of reanalysis data is made for a longer period using all available data. They include NCEP/NCAR,NCEP/DOE, ERA-40, JRA-25 and NASA-MERRA.

Reanalysis data in general shows reasonable intraseasonal variability over the Arctic. In the stratosphere, the NCEP/NCAR underestimates the record-breaking SSW in 2009 while ERA-Interim overestimates it. The magnitudes of the biases are about 10K at 10 hPa. It is however found that the two reanalyses data are quantitatively similar to observations in the upper troposphere. Inter-comparison among reanalysis data further reveals that all reanalysis data have reasonable polar climate variability in the upper troposphere and stratosphere. Although reanalysis data might be highly sensitive to data assimilation particularly over the Arctic, intensity of the SSW and VI and the associated downward propagation are quite similar among the reanalysis data.

POSTER Climate Change and Extreme Events / AFFICHE Le changement climatique et les évènements extrêmes

Room / Endroit (Terrace / Terrasse), Chair / Président (Chad Shouquan Cheng), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0302.1 ID:3678 16:00

Extreme Precipitation Events in the Present and Future Climate Over Several Canadian Locations

Daniel Betancourt , *Ronald Stewart*
University of Manitoba, Dept of Environment and Geography
Contact: dbetanco2007@gmail.com

Extreme precipitation events have significant societal impacts. For example, excessive run-off may trigger flash floods causing risk of injury or death. They may also lead to a contamination of drinking supplies from agricultural run-off as was the case in Walkerton ON during the spring of 2000. In the context of increased atmospheric CO2 concentration, future occurrences of such events may increase. Trends in precipitation extremes (90th, 99th and 99.9th percentile) are being analyzed for five selected locations across Canada (in Alberta, Saskatchewan and Ontario). The sites were chosen with the consultation of human health scientists within the Canadian Water Network. The Canadian Regional Climate Model (CRCM version 4.2.0) is being used to carry out the study. Results from the model's base period simulation (1971-2000) are being compared to those from a future scenario of increased atmospheric CO2 (IPCC SRES A2 from 2041-2070). The climatology of nearby Environment Canada weather stations was examined to assess the model's ability to simulate the present and future climate. Other parameters such as 850 and 500 hPa flow associated with extreme events are being analyzed to infer any changes in the large and regional scale factors leading to such events. The most dramatic events in the present climate are mainly confined to the warm season at all locations although a number occur during the cold season at the Ontario sites. Preliminary results for the future climate suggest small increases in extremes for all locations with the largest increases over Ontario. These and other results will be shown in the presentation.

1P30-0302.2 ID:3599 16:00

The « blocked » summer of 2009 over Eastern Canada

Marc Beauchemin
Environment Canada
Contact: marc.beauchemin@ec.gc.ca

The summer of 2009 in Canada was unusual and extreme on several aspects, with numerous tornado outbreaks, cold and wet spells, and late summer/early autumn heat waves and dry spells. In eastern Canada, several extremes were due to atmospheric blocking events. Blockings were abnormally high during this season, as it was the case in summer of 2008. This paper examines the blocking events of 2009 in comparison with previous years, as well as the mechanisms

linked with the occurrence of extreme events and anomalies in climatic surface conditions. Because of their relationship with short-term persistence and atypical climatic conditions, blocking events and their variability play a crucial role in measured trends of surface extremes at intra-seasonal and interannual timescales.

1P30-0302.3 ID:3602 16:00

The 2007-2008 snow season in southern Quebec and Ontario in a historical perspective

Marc Beauchemin
Environment Canada
Contact: marc.beauchemin@ec.gc.ca

The 2007-2008 snow season was exceptional based on several indices. Seasonal snow amounts, snowstorm frequency and intensity, daily snowfall frequency distribution, maximum snow depth, and other indices showed exceptional values and even record breaking in some localities across Québec and Ontario. This contrasts with the winters of the 80’s and 90’s which showed generally lower than normal values for these snow indices. Extreme snow seasons are an important issue in the St-Lawrence river – Great Lakes corridor since half of the country’s population lives there (17 million), as the winter weather systems have potentially high impacts on transportation, energy demand/production and on the economy as a whole. The characteristics of these events are analyzed in the context of historical variability and trends.

POSTER Climate change and the carbon cycle / AFFICHE Le cycle du carbone et les changements climatiques

Room / Endroit (Terrace / Terrasse), Chair / Président (Kirsten Zickfeld), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0303.1 ID:3683 16:00

Evaluating Historic Carbon Budget in a Temperate Pacific Northwestern Conifer Forest Landscape Using CN-CLASS Model

Bin Chen
American Geophysical Union
Contact: chenb9@mcmaster.ca

We used carbon and nitrogen coupled Canadian Land Surface Scheme (CN-CLASS), a process-based model, to simulate historic carbon stocks and fluxes in a 2500 ha Pacific Northwest temperate conifer forest landscape from 1920 to 2005. Hourly meteorological data used to drive the model were derived from historic climate records. Site maps of soils, topography, vegetation and disturbance history (logging and fires) were provided by the historic carbon modeling project of the Canadian Carbon Program (CCP). The initial aboveground tree biomass in 1920 and the disturbance matrices were produced by the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3). Over the study period from 1920-2005, CN-CLASS simulated 186 Mg C ha^{-1} loss of ecosystem carbon as compared to 287 Mg C ha^{-1} loss suggested by CBM-CFS3 using historic inventory records. From 1928 to 1949, burning, harvest and slash burning resulted in large losses of carbon with CN-CLASS modeled carbon loss of 276 Mg C ha^{-1}. From 1950 to 1989, there were very few disturbance events and the study area started to recover with simulated net carbon uptake of 94 Mg C ha^{-1}. During this period, CN-CLASS modeled annual Net Biome Productivity (NBP) ranged from 5 g C m^{-2} yr^{-1} in 1958 to 458 g C m^{-2} yr^{-1} in 1964. CN-CLASS simulated landscape-level annual net ecosystem productivity (NEP) deviations during the undisturbed period (1963-1984), showed a negative relationship with the daily minimum or maximum air temperature in spring (March-May) or summer (June-August). Comparison of modeled monthly NEP with eddy-covariance flux measurements for a 17 ha 1949-origin stand, showed modeled NEP roughly captures the seasonal variation, especially in years 1999, 2000, 2002, 2003 and 2004, although NEP in the last two months of each year was underestimated. This study will help to explore the impact of climate variability and disturbance on landscape-level carbon dynamics.

1P30-0303.2 ID:3688 16:00

Modeling Historic Carbon Dynamics of a Boreal Black Spruce Forest Landscape in Chibougamau Quebec using CN-CLASS

Bin Chen
American Geophysical Union
Contact: chenb9@mcmaster.ca

The CN-CLASS model was used to simulate the historic carbon budgets in a 6275 ha old black spruce forest landscape in Chibougamau, Quebec. The purpose of this study was to evaluate the performance of CN-CLASS model to simulate the impact of disturbance and climate variability on the carbon dynamics of boreal forest landscape in eastern Canada. The disturbance matrix of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) model was used to represent the impact of different disturbance events on the carbon fluxes among different forest carbon pools and the atmosphere. Landscape maps of soil, vegetation and inventory data in 1928 and historic disturbance data were used for model parameterization. Hourly meteorology data, constructed from climate records, were used to drive CN-CLASS model to simulate the annual carbon fluxes and carbon stocks from 1928 to 2005. Over this study period, CN-

CLASS suggests 18.7 Mg C ha^{-1} increase of total ecosystem carbon (TEC) as compared to 12.2 Mg C ha^{-1} increase estimated by CBM-CFS3. In 1963, around 689 ha were disturbed and large amount of carbon were transferred out of the forest. Between 1970 and 2005 very few disturbance events occurred in the study area and landscape-level TEC increased from 61 to 69 Mg C ha^{-1}. During this period, CN-CLASS modeled Net Biome Productivity (NBP) ranged from -0.2 Mg C ha^{-1} yr^{-1} in 2005 to 0.6 Mg C ha^{-1} yr^{-1} in 1977 mostly determined by inter-annual climate variability. The simulated annual net ecosystem productivity (NEP) deviations of the undisturbed forest from 1928 to 1999 were negatively related to mean annual air and soil temperatures and mean annual soil moisture. This study will help to explore the impact of forest management and future climate change on boreal forest productivity in eastern Canada.

1P30-0303.3 ID:3421 **16:00**

Methane Dynamics of Revegetated Cutover Minerotrophic Peatlands: Implications for Restoration.

Md. Sharif Mahmood
University of Calgary
Contact: msmahmoo@ucalgary.ca

Peatlands play an important role in the global carbon cycle storing at least 25% of world soil carbon while emitting a significant amount of methane (CH4) to the atmosphere. The impacts of peat harvesting on the peatland ecosystems are severe as it completely removes living vegetation and changes hydrology, converting the peatland into a net source of carbon. In Canada horticultural peat extraction contributes to drainage and extraction of over 12,000 ha of peatlands. In North America mulching of vacuum harvested sites combined with blocking of the drainage system is a widely used for peatland restoration to accelerate Sphagnum establishment. However, peat extraction in fen peatlands often exposes deeper minerotrophic peat layers resulting in soil chemistry that is less suitable for re-establishment of Sphagnum moss and mulching appears to increase carbon loss from the ecosystem thus impeding recovery of the carbon sink function. In this situation restoration of plant species characteristic of minerotrophic peatlands is desirable to return the site into a carbon accumulating system. In these cases, it may be worthwhile to maintain spontaneously revegetating species as part of restoration if they provide desirable ecosystem functions. We studied the role of six revegetating species for methane (CH4) emissions for two growing seasons (2008 and 2009) at an abandoned minerotrophic peatlands in south-eastern Quebec. We used static chamber methods to determine CH4 emission rates. We then compared the result with bare peat and adjacent natural fen vegetation. Our results showed that E. vaginatum, C. aquatilis and Typha latifolia have CH4 flux an order of magnitude greater than other vegetation and natural sites. However S. atrocinctus and E. arvense showed promising results and their CH4 emission rates are even lower than natural hollow vegetation. This suggests that some revegetating species can be kept during restoration although more research is needed to see the condition after rewetting.

1P30-0303.4 ID:3773 16:00

Drivers of North American continental runoff change and implications for ocean circulation

Kelly Nugent
Department of Geography, Planning and Environment, Concordia University Montreal
Contact: nugent.kelly2@gmail.com

Identifying the potential drivers of North American runoff change is important for understanding current and predicting future hydrological responses to climate change. Probable drivers of precipitation and evapotranspiration changes include atmospheric aerosols, land cover change, vegetation responses to atmospheric carbon dioxide (CO2) and climate warming. In this study, we assessed the effect of each of these processes on recent and future continental runoff, using the University of Victoria Earth System Climate Model. First, we validated our simulations against a twentieth century observational dataset derived from the Global Runoff Data Centre (GRDC). Projections of runoff over the 21st century were evaluated relative to the baseline year of 1850, grouped according to six major river basins covering North America. Results suggest that anthropogenic influences have contributed to changes in continental runoff, though we found significant regional variation in runoff changes, which suggests the need for locally-specific management practices. We further assessed the possibility that increased freshwater discharge to the North Atlantic may affect surface ocean stratification and ocean circulation. Given North America’s proximity to an important area for deep-water formation, assessing the impact of runoff changes may be important in understanding and projecting future changes in the Atlantic Meridional Overturning Circulation.

POSTER Lawrence Mysak Session on Ocean and Climate Dynamics / AFFICHE Séance Lawrence Mysak sur la dynamique des océans et du climat

Room / Endroit (Terrace / Terrasse), Chair / Président (W. Hsieh), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0401.1 ID:3349 16:00

Probabilistic assessment of climate system properties and their affect on the rate of climate change

Andrew Ross , *Damon Matthews*
Concordia University
Contact: an_r@live.concordia.ca

Climate models are an important tool for assessing future climate changes and evaluating the possible impacts associated with certain climate change scenarios. However, all climate model projections are subject to large uncertainty; quantifying this uncertainty is crucial to formulating accurate predictions of future climate change. One useful approach is the use of a probabilistic framework to assess the likelihood of key climate system properties and their effect on future projections. In this study, we have used probability density functions of climate sensitivity and ocean vertical diffusivity to generate a probabilistic prediction of maximum rates of temperature warming over the 21st century. Using the UVic ESCM (University of Victoria Earth System Climate Model), we systematically varied the model's climate sensitivity and ocean diffusivity parameters to yield a range of climate responses to a common CO2 emission scenario. We assigned probabilities to each model configuration, and calculated the likelihood of exceeding various rates of warming over the next century. We found that the maximum decadal rate of temperature change varied from 0.27°C per decade for a climate sensitivity of 1.5°C to nearly 0.92°C per decade for a climate sensitivity of 7.5°C. The risk of rapid climate change associated with high rates of warming is highly relevant to discussion of climate policies aimed at avoiding 'dangerous anthropogenic interference' in the climate system, as many environmental systems and the adaptive capacity of species are dependent on the rate by which climate changes.

POSTER Atmosphere-Ocean Interactions & Waves / AFFICHE Interaction atmosphère-océan et les vagues

Room / Endroit (Terrace / Terrasse), Chair / Président (William Allan Perrie), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0403.1 ID:3303 **16:00**

High-order methods for weakly non-hydrostatic layered models

Derek Steinmoeller , *Marek Stastna* , *Kevin Lamb*
University of Waterloo

Contact: dsteinmo@math.uwaterloo.ca

In recent years, there has been an increasing demand for shallow water models that can properly address both long wave and dispersive short wave phenomena. In this study, we examine how Fourier/Chebyshev pseudospectral methods can be efficiently used to solve the dispersion-modified shallow water model, first derived by Brandt et. al. (1996), on simple idealized model geometries. Two approaches are considered for addressing the dispersive-correction terms: 1. A direct time-stepping approach, and 2. Introduction of an auxiliary elliptic equation. Run-times for both approaches will be compared, and parallelization techniques will be discussed.

References:

1. Brandt, P., A. Rubino, W. Alpers, J.O. Backhaus, 1996: Internal Waves in the Strait of Messina Studied by a Numerical Model and Synthetic Aperture Radar Images from the ERS 1/2 Satellites, J. Phys. Oceanogr., 27, 251-269.

1P30-0403.2 ID:4037 16:00

Wave Modelling Using TSA for the Non-Linear Wave Interactions

Jean-Pierre Auclair [1], *William Perrie* [2], *Bechara Toulany* [2]
[1] Dalhousie University
[2] Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

Evaluation of the non-linear wave-wave energy transfer represents a significant proportion of the computation time of ocean wave models and currently limits the accuracy of wave modeling. This poster presents the implementation of the Two-Scale Approximation (TSA) in WAVEWATCH III as a method to calculate the non-linear wave interactions, thus replacing the Discrete Interaction Approximation (DIA). The TSA, developed by (Resio and Perrie, 2008), uses a decomposition of the wave energy spectrum into broad and local scales in order to achieve a more accurate calculation of the non-linear energy transfer while maintaining a high computational efficiency. Tuning of the other source terms of the wave energy equation (wind input and wave dissipation) was performed and results for fetch-growth curves and SWAMP-type tests are presented. The differences in the dynamics of wave evolution between the new model and the release version are studied in different theoretical test cases including wave generation by stationary and translating Holland-type vortices as well as propagation into shallower waters. Comparisons between the different versions of the wave models consider both integrated variables and spectral characteristics for a complete analysis of the skill of the models. The accuracy gained by using the TSA over the DIA is then considered along the changes in computational efficiency to assess the viability of the TSA in operational ocean wave forecasting.

Resio, D. T. and W. Perrie, 2008. A two-scale approximation for efficient representation of nonlinear energy transfers in a wind wave spectrum – part 1: Theoretical development. Journal of Physical Oceanography, 38: 2801-2816.

1P30-0403.3 ID:4053 **16:00**

Broad-Scale Parametric Spectral Form for TSA

Fumin Xu [1], *Will Perrie* [1], *Don Resio* [2]
[1] Bedford Institute of Oceanography
[2] ERDC-Coastal and Hydraulics Lab, USA
Contact: perriew@dfo-mpo.gc.ca

A Two-Scale approximation (TSA) method (Resio and Perrie, 2008; Perrie and Resio, 2009) was proposed to efficiently accurately estimate the full Boltzmann integral (FBI), in operational wave forecast models. TSA's accuracy depends on the accuracy used in the broad-scale component of the spectrum which usually is the dominant component of nonlinear wave-wave interaction term (Snl), and the residue part which has the same number of degrees of freedom as the modeled spectrum. The improved JONSWAP spectrum (Goda, 1987), and other two spectral forms, JONSWAP spectrum and a spectrum follow the form (Resio and Perrie, 1989), are used in the determination of Snl. Their roles in the computation are: JONSWAP spectrum is used as an experimental target spectrum, the spectrum from Resio and Perrie (1989) is used as experimental broad-scale parametric spectrum; both of these spectra are applied in FBI to calculate the broad-scale Snl in for parameters. While, the improved JONSWAP spectrum is the broad-scale parametric spectral form, which is used to simulate the realistic spectrum or model simulated spectrum, and also to determine spectral parameters (peak-enhancement factor, energy scale parameter), which correspond to the JONSWAP spectral parameters. Thus, the improved JONSWAP spectrum actually acts as a bridge between JONSWAP spectrum and real spectra, or between JONSWAP spectrum and numerical simulated spectrum during a wave model simulation process. Parameters used in broad-scale spectrum are analyzed, and the method is discussed. The upper and lower limits are analyzed, in order to define the discrete number and interpolation of these parameters for future wave model operational forecasting. It can be foreseen that only two parameters (directional distribution power, peak-enhancement factor) in the broad-scale Snl estimation of TSA can give good approximations. Sensitivities of the these parameters to Snl are checked and analyzed, it is obvious that a small variation in the energy scale parameter, spectral peakedness, directional spreading and peak frequency will lead to tremendous change in Snl.

POSTER Coupled Atmosphere-Ocean Prediction and Predictability / AFFICHE Prévision et prévisibilité avec modèles couplés atmosphère-océan

Room / Endroit (Terrace / Terrasse), Chair / Président (Susan K. Woodbury), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0404.1 ID:3950 16:00

Inter-connections among three vector spaces in a 4D-Var system

Tsuyoshi Wakamatsu , *Michael Foreman*
School of Earth and Ocean Sciences, University of Victoria / Institute of Ocean Sciences, DFO
Contact: tsuyoshi.wakamatsu@dfo-mpo.gc.ca

Control parameters, model state and data spaces are three key vector spaces on which a 4D-Var data assimilation system is constructed. The recent study by El Akkraoui and Gauthier (2010) revealed a clear connection between cost functions for the model state and data spaces and its consequence on the performance of the descent algorithms. In this study, we further explore the inter-connections among the cost functions, their gradients and Hessian matrices of a 4D-Var system written in the three vector spaces.

1P30-0404.2 ID:3801 16:00

Hindcast simulations of the Arctic Ocean

Sarah Lundrigan , *Entcho Demirov*
Department of Physics and Physical Oceanography, Memorial University of Newfoundland
Contact: entcho@mun.ca

Ensemble hindcast simulations of the interannual variability of the Arctic Ocean are done using a course resolution, coupled ocean/sea-ice model (NEMO-OPA/ NEMO-LIM). The model is forced using atmospheric parameters from NCEP/NCAR reanalysis for the most recent 50 years. The interannual variability of the properties of the main water masses, general circulation and of the volume, heat, and salt fluxes through the straits are evaluated. The quality of the model is assessed using observations.

1P30-0404.3 ID:3639 16:00

Simulation of the Mixed Layer Depth in the North Pacific Ocean using NEMO with Spectral Nudging

Yunfeng Shao [1], *Michael W. Stacey* [2]
[1] Department of Physics, Royal Military College of Canada
[2] Department of Phycics, Royal Military College of Canada
Contact: yunfeng.shao@rmc.ca

Results from a NEMO (Nucleus for European Modelling of the Ocean) simulation implementing spectral nudging are presented of the circulation of the North Pacific Ocean. The model domain extends from 50 N to 660 N (to include the Bering Sea but not equatorial dynamics). The horizontal spatial resolution is 0.25 degrees and there are 46 unequally spaced vertical levels. The model is forced with NCEP monthly winds, precipitation, sea-surface heat flux and sea-surface pressure. Results comparing the mixed layer depth (MLD) from our model are made to a similarly forced POP (Parallel Ocean Program) model to see if the recent shoaling trend is reproduced by NEMO as it is in POP.

1P30-0404.4 ID:3848 **16:00**

Assessment of the hindcast of the Labrador Sea

Jieshun Zhu , *Entcho Demirov*
Department of Physics and Physical Oceanography, Memorial Univeristy of Newfoundland
Contact: jszhu@mun.ca

Assessment of hindcast of the Labrador Sea for the period of time from 1948 to 2005 are present. The ocean model of this study is NEMO (Nucleus for European Modelling of the Ocean), which is implemented for the region of the North Atlantic with 1/4 degree horizontal resolution and 46 vertical levels. The surface atmospheric forcing is calculated with NCEP atmospheric reanalysis. The model drift is constrained by using an approach based on the spectral nudging method suggested by Thompson et al. (2006). The ocean model reproduces well the observed decay of the sub-polar circulation in the late 1990s and most important patterns of variability of temperature and salinity in the Labrador Sea Water (LSW) in the past five decades.

POSTER Operational Oceanography: observations, modelling and data assimilation / AFFICHE Océanographie opérationnelle : observations, modélisation et assimilation des données

Room / Endroit (Terrace / Terrasse), Chair / Président (Gregory Smith), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0503.1 ID:4013 16:00

An Ocean Forecast Monitoring and Validation System for C-NOOFS

Charlie Bishop [1], *Andry Ratsimandresy* [1], *Gregory Smith* [2], *Jennifer Wells* [1], *Fabrice Hernandez* [3], *Fraser Davidson* [1]
[1] Northwest Atlantic Fisheries Centre, DFO
[2] Meteorological Research Division, EC
[3] Mercator-Ocean
Contact: davidsonf@dfo-mpo.gc.ca

A monitoring system has been developed for the Canadian-Newfoundland Operational Ocean Forecasting System (CNOOFS). The C-NOOFS system runs two forecasts daily: NWA025 and NWA12 with 1/4 (20km) and 1/12 (6 km) degree resolution respectively. The monitoring system uses sea surface height (SSH) from AVISO and sea surface temperature (SST) and ICE analyses provided by Canadian Meteorological Center/Canadian Ice Services (CMS/CIS) to determine the error in our forecast runs. The model forecast domain is broken into 26 geographical zones and the monitoring system is run on each to produce plots of RMS and Mean error vs. forecast lead day for various variables (Sea Surface Height, Sea Surface Temperature, Ice Concentration). The results of the NWA monitoring are then compared against other forecast systems including Mercator-Ocean PSY3 and PSY2. Here we will present details on the monitoring package along with averaged performance statistics over a 1 year trial period.

POSTER Remote Sensing of the Oceans / AFFICHE Téléobservation des océans

Room / Endroit (Terrace / Terrasse), Chair / Président (Howard R. Edel), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0508.1 ID:3560 16:00

Verification of Marine Wind Speeds Derived from SAR Observations

Alexander Komarov , *Vladimir Zabeline*
Meteorological Service of Canada, Environment Canada
Contact: alexander.komarov@ec.gc.ca

The Wind Information Processing System (WIPS) for the routine surface wind speed retrieval over Canada’s West and East coasts is being currently implemented at the Network and Strategies and Design, Meteorological Service

of Canada, Environment Canada as a short two-year long pilot project. The system operates with RADARSAT-1, 2, and ENVISAT satellite imagery with very high resolution. The technology is able to map wind speed with 500 m. Wind directions that are required for the wind retrieval algorithm (CMOD_IFR2) are provided by different Numerical Weather Prediction models. The verification of the derived wind speeds is necessary in order to evaluate the performance of the WIPS system for different areas, wind speeds, and directions. The most reliable and easy available source of the observed wind speeds is buoy data. However, there is a significant difference (up to 30 min) between SAR observation time and the nearest buoy observation time. In addition, the wind speed retrieval algorithm generates an instantaneous velocity field over a large water area, while a buoy measurement is point average wind speed and direction for a 10 minute time interval. These limitations create significant difficulties for verification of wind speeds derived from SAR data. A new verification approach that rationally compares the retrieved wind speeds from SAR data to buoy measurements is proposed. The verification methodology takes into account the limitations of wind speeds from SAR and buoy data (time difference between SAR and buoy observations as well as the 10 min time period required for buoy data collecting and averaging). The verification technique will be applied to output products of the WIPS system based on available buoy data. The analysis of the relationship between wind speeds from SAR and buoy data will be conducted for different time intervals between SAR and buoy data and different time intervals between model wind directions and SAR observations. The work is conducted at the Meteorological Service of Canada, Environment Canada as a part of the National SAR Wind project. The project is supported by the Canadian Space Agency through the Government Related Initiative Program (GRIP).

1P30-0508.2 ID:3583 16:00

Change in RADARSAT-2 dual-polarization backscatter intensity over the Great Lakes ice cover during Winter 2009-2010

Nicolas Thai Nguyen
(Presented by *Gaetan Langlois*)
Environment Canada - Canadian Ice Service
Contact: nicolas.nguyen@ec.gc.ca

The Great Lakes are the world’s largest freshwater surface, covering an area of 245 000 km2. Ice cover is a critical alteration of the physical characteristics of the lakes, and has a major impact on lake-atmosphere interactions affecting regional climate as well as on shipping industry. The large-scale nature of the ice cover in large lakes requires the use of satellite SAR data to satisfy both the necessary high resolution and the large areal coverage. As Canada’s leading source of ice information, the Canadian Ice Service has been investigating the potential of RADARSAT-2 dual-polarization (HH-HV) image products for application to: a) the mapping of lake ice cover characteristics, and b) the monitoring of change in lake ice cover characteristics over the winter season. For the duration of the 2009-2010 ice season, RADARSAT-2 was tasked to image the Great Lakes on a daily

basis. Ice extent, type, and concentration were identified by specialists at the Canadian Ice Service. Ice thickness information were also collected by the Canadian Coast Guard. This project studies the change in RADARSAT-2 dual-polarization backscatter intensity from lake ice cover as function of time. RADARSAT-2 sensitivity to the onset of ice formation, the nature of ice cover observed, and the growth of the ice cover over the winter season is also determined.

1P30-0508.3 ID:4107 16:00

Validation of MERIS ocean colour products over Atlantic Canada

Gordana Lazin [1], *Edward Horne* [1], *Carla Caverhill* [1], *Gary Bugden* [1], *Susanne Craig* [2]
[1] Bedford Institute of Oceanography, DFO
[2] Dalhousie University
Contact: Gordana.Lazin@dfo-mpo.gc.ca

Since May 2008, thanks to a CSA-ESA agreement and to CCRS, DFO gained access to daily MERIS FR data over Canadian waters. The availability of 300 m resolution ocean colour images created enormous potential for coastal water monitoring, as those are most biologically productive and most influenced by human activity. As with any other sensor the match-up of satellite-derived products with in-situ observations is crucial to evaluate their quality, accuracy and temporal stability. Here we present validation results of MERIS reflectance and chlorophyll products in the Atlantic Canada. We compare Level 2 products provided by ESA, and two independent processing algorithms (C2R and FUB) with the in-situ data collected in the Bay of Fundy and Bedford Basin during 2008 and 2009, as well as at several open ocean locations.

POSTER Weather and Society - Integrated Studies / AFFICHE La météo et la société - Études intégrées

Room / Endroit (Terrace / Terrasse), Chair / Président (Jacques Descurieux), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0602.1 ID:4041 16:00

Have you seen the wind? Results from a 2009 windspeed and wind impacts study.

Lisa Vitols [1], *Avee Ya'acoby* [2]
[1] Environment Canada

[2] University of BC
Contact: lisa.vitols@ec.gc.ca

Wind impacts affect all regions of Canada, from coast to coast, urban to rural, and inland and offshore areas. For the past three years the Service Development office of the MSC has been engaging Canadians on how they use weather information for decision-making. Consultations with key decision-makers revealed that current wind warnings may not be relevant to some MSC clients as there are no significant impacts at existing warning thresholds. In addition, communication with members of the general public suggests that numeric wind speed values are not well understood. In an effort to better inform how forecast information is described and disseminated, an innovative outreach research program was developed to gauge public perceptions of wind. This presentation will describe the methodology and results of asking Canadians "have you seen the wind?"

POSTER Drought, Climate and Society / AFFICHE Sécheresse, climat et société

Room / Endroit (Terrace / Terrasse), Chair / Président (Ron Stewart), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0606.1 ID:4608 16:00

Urban Dry Islands and Potential Impacts on Convective Environments and Drought

Geoff Strong
Adjunct Prof., Earth & Atmospheric Sciences, University of Alberta
Contact: geoff.strong@shaw.ca

While conducting mobile surface transects during the 2008 UNSTABLE thunderstorm field project, an 'urban dry island' was detected over small central Alberta towns such as Wetaskiwin (pop. 12,000) and Ponoka (pop. 6,500). The dry island was estimated to be close to 1 g kg-1 mixing ratio; that is, measured average mixing ratios within towns were 1 g kg-1 lower than that measured while driving between agricultural crops on either side of roadways. The average 'heat island' effect was 0.5 °C or less within these small urban centres. This prompted an investigation of the urban dry island over larger cities such as Edmonton (pop. 780,000).

Mobile transects were subsequently carried out across Edmonton in E-W, NE-SW, and SE-NW directions on 15 days during mid-summer of 2009. Edmonton's urban heat island, after eliminating diurnal effects, averaged between 2 and 3.5 °C, depending on cloud conditions. This corresponded well with earlier estimates by Strong (2005) using climatological data from Edmonton Municipal and International Airports. The urban dry island varied from 1 g kg-1 under cloudy conditions to an unexpectedly high 3 g kg-1.

The impact of these horizontal gradients of temperature and moisture across large urban areas such as Edmonton are contemplated in terms of their diurnal influence on daily convective environments, and their seasonal effect on the initiation and cessation of drought in the context of the Drought Research Initiative (DRI).

1P30-0606.2 ID:3855 16:00

A comparison of crop evapotranspiration estimates from PAMII1+2, FAO56P-M and water balance models

Manasah Mkhabela , *Mark Gervais* , *Paul Bullock*
University of Manitoba
Contact: mkhabela@cc.umanitoba.ca

Evapotranspiration (ET) models have become essential tools in areas such as climate modelling, weather forecasting, crop yield forecasting and irrigation planning. The modified second-generation Prairie Agrometeorology Model (PAMII1+2) estimates ET by simulating crop development and the soil water balance using minimal, commonly measured, surface weather parameters, i.e., daily minimum and maximum surface air temperature and daily rainfall. This maximises the number of weather stations that can be utilised, and as a result, maximises the spatial resolution of ET estimates. PAMII1+2 estimates crop ET using a vapour density deficit approach that is moderated by canopy, soil and an aerodynamic resistance that utilises upper air conditions to simulate the depth of planetary boundary layer. The FAO56 Penman-Monteith (FAO56 P-M) method uses a reference surface/combination approach. The simplified water balance method estimates ET as the residual of precipitation and the change in soil water. The objective of this study was to compare ET estimates from PAMII1+2 to those derived from FAO56 P-M and the water balance. Comparison of daily ET between PAMII1+2 and FAO56 P-M indicated significant differences in the estimated crop water demand (ETc) (RMSD = 1.88 mm d-1, r2 = 0.45) and actual ET (ETa) (RMSD = 1.65 mm d-1, r2 = 0.45). When compared to the water balance derived ET, PAMII1+2 (slope= 0.65, r2 =0.62) produced more accurate estimates of ETa than FAO56 P-M (slope = 0.50, r2 = 0.61). However, both models produced overall ET estimates that fell within the range of the measurement error associated with the water balance ET method. Since PAMII1+2 produced relatively accurate estimates of crop ETa, while using minimal surface weather parameters, this model would therefore be useful for deriving regional crop ET estimates on the Canadian Prairies.

POSTER The Arctic Environment in the 21st Century / AFFICHE L'environnement arctique au 21e siècle

Room / Endroit (Terrace / Terrasse), Chair / Président (James R. Drummond), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0701.1 ID:3511 **16:00**

Modelling lake ice thickness – a comparison of measured and simulated ice thickness from the 2008-2009 ice season in Churchill, Manitoba.

Laura Brown , *Claude Duguay*
University of Waterloo
Contact: lcbrown@uwaterloo.ca

Lakes comprise a large portion of the surface cover in Northern Canada forming an important part of the cryosphere, with the ice cover both playing a role in and responding to climate variability. In northern regions where observational data is sparse, lake ice models are ideal as they can provide valuable information on ice cover regimes. One important benefit of modelling is the ability to simulate ice conditions under future climate scenarios and examine the changes to the break-up/freeze up, thickness and ice composition that may occur. However, before future conditions can be explored, models need to be validated against current conditions to improve predictions. The Canadian Lake Ice Model (CLIMo) was used to simulate ice cover for a lake near Churchill, MB (58.72N, 93.78W) throughout the 2008-2009 winter season, driven by on-shore meteorological data from an Automated Weather Station (AWS) and the MODIS cloud cover product. In addition to the meteorological data, a Campbell Scientific digital camera was installed, capturing images of the lake to provide observations of the ice processes. In order to validate and improve the model results, in situ measurements of the ice cover formation and decay were obtained using an upward looking sonar device (Shallow Water Ice Profiling Sonar - SWIPS) installed on the bottom of the lake. The SWIPS identified the ice-on/off dates as well as collected continuous ice thickness measurements. Additionally, field measurements were obtained during the spring of 2009 of snow depth on the ice, and both the thickness of snow-ice (if present) and total ice cover. Preliminary results show good agreement between the model simulations and observations for the timing of freeze-up, however the model simulations for break-up preceded observations and tended to misrepresent the ice thickness. Further simulations seek to reduce discrepancies between the observed and simulated ice cover

thickness and the timing of break-up.

1P30-0701.2 ID:3751 16:00

Volume and thickness changes of the Milne Ice Shelf, Ellesmere Island, Nunavut, 1981 - 2009

Colleen Mortimer [1], *Luke Copland* [1], *Derek Mueller* [2]
[1] University of Ottawa, Department of Geography
[2] Canadian Ice Service
Contact: colleenmortimer@gmail.com

This study reports on the characteristics and recent changes of the Milne Ice Shelf, northern Ellesmere Island. Canada has lost >90 % of its ice shelves over the last century, including a 23% decrease in areal extent in summer 2008 alone. Existing knowledge of changes to Ellesmere Island's ice shelves is mainly restricted to changes in area, with few measurements of changes in ice thickness. In this study, we use new ice depth measurements from ground penetrating radar surveys completed in 2008 & 2009 to produce a detailed thickness map of the Milne Ice Shelf and to quantify its current volume.

In addition, this study compares current ice shelf thicknesses to those obtained from a 1981 radio-echo sounding survey. Direct comparison of a single transect revealed thinning of up to 5 meters. For the ice shelf as a whole, we incorporate air photo and satellite image analysis to provide the first determination of changes in total volume of an Ellesmere Island ice shelf over the last 25+ yrs.

1P30-0701.3 ID:3760 16:00

Reductions in Multiyear Sea Ice in Yelverton Bay, Ellesmere Island, Canada

Sierra Pope [1], *Luke Copland* [1], *Derek Mueller* [2]
[1] University of Ottawa
[2] Canadian Ice Service
Contact: spope051@uottawa.ca

Recent decreases in ice shelf extent have occurred in tandem with reductions in area and thickness of multiyear sea ice in the northern Canadian Arctic Archipelago (CAA). On northern Ellesmere Island, air photo mosaics created from 1950s imagery indicate that the presence of persistent MLSI created an incipient ice shelf that extended 20-30 km into Yelverton Bay. Most of this MLSI (690 km2) was lost in August 2005, shortly after the loss of the nearby Ayles Ice Shelf. Recent RADARSAT images indicate that the MLSI fragments remaining after the August 2005 break-up event were refrozen into the first year sea ice in Yelverton Bay during the winters of 2005 through 2007, but drifted out of outer Yelverton Bay in late summer 2008 during a period of further ice shelf breakups.

To assess the impact of recent MLSI changes and quantify current sea ice conditions, field measurements were completed in Yelverton Bay and Yelverton

Inlet in June 2009. Sea ice thicknesses in the Bay and Inlet were determined using a 500 MHz GPR system, with shallow (<3 m) ice cores used to both validate the GPR thickness readings and to measure temperature and salinity of the sea ice. Ice core profiles suggest that Yelverton Bay is now composed largely of first and second year sea ice, confirming analysis of March and June 2009 RADARSAT-2 imagery. The removal of MLSI from Yelverton Bay—and the replacement of this old, thick ice with a thinner, more vulnerable first and second year sea ice matrix—represents a significant change to the old ice regime in the Arctic.

POSTER General Hydrology Session / AFFICHE Séance générale sur l'hydrologie

Room / Endroit (Terrace / Terrasse), Chair / Président (Sean Carey), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0801.1 ID:3402 **16:00**

Field observation of vadose zone response to pumping in a shallow water table aquifer.

Melissa Bunn , *Jon Paul Jones* , *Anthony Endres*
University of Waterloo
Contact: mbunn@uwaterloo.ca

A 24 hour pumping test was conducted in the Borden aquifer (CFB Borden, ON) in October 2009. Prior to pumping the water table was less than 1 m below ground surface, which allowed for the installation of various instrumentation within the capillary fringe. Tensiometer profiles were installed through the capillary fringe at 2 m and 4m from the pumping well. Moisture contents were observed using both TDR and neutron logging techniques. The objectives of this study were to monitor the development of vertical gradients throughout the saturated zone, to determine the accuracy of the neutron probe in the Borden aquifer, and to closely observe the vertical gradient and hydraulic head distributions in the early portions of pumping and recovery. The magnitude of the vertical gradients peaked early in the test and slowly decreased until the end of pumping. A lag was observed between the end of pumping and the reversal of the direction of vertical flow. Horizontal flow was the dominant process during the recovery portion of the test, as the vertical gradients were significantly lower in comparison to the pumping portion of the test. Vertical gradients observed below the water table during the test were of the same order as those observed within

the capillary fringe, confirming the assumptions made in previous numerical simulations of the aquifer.

1P30-0801.2 ID:3403 16:00

Monte Carlo simulation of a pumping test conducted in a mildly heterogeneous unconfined aquifer

Melissa Bunn , *Jon Paul Jones* , *Anthony Endres* , *David Rudolph*
University of Waterloo
Contact: mbunn@uwaterloo.ca

In 2005 a seven-day pumping test was conducted in the Borden Aquifer (CFB Borden, ON). A large number of observations were made during the test, which has driven numerous numerical investigations into the response of unconfined aquifers to pumping induced drawdown. Many numerical simulations of this test have been conducted using a variety of saturated-unsaturated flow codes, with a homogeneous conceptual model of the aquifer. This study was conducted to determine the impact of a heterogeneous conceptualization on the simulation results. A total of 75 realizations of the heterogeneous hydraulic conductivity field were performed using the flow code Hydrogeosphere (HGS). A Monte Carlo analysis was performed on the simulation results. The hydraulic head drawdown predicted by the ensemble mean of the heterogeneous simulations differs from that predicted by a homogeneous numerical simulation. The ensemble mean result provides a better fit to the field data at early and intermediate times. Moisture profiles generated by the heterogeneous realizations differ from realization to realization but the ensemble mean result is not significantly different from the homogeneous simulation. The impact of site conceptualization on simulation results in such a mildly heterogeneous aquifer illustrates the importance of a full understanding of the site geology in all simulation studies.

1P30-0801.3 ID:3416 16:00

Ice Jams and River Dynamics: A Field Study of the East Humber River

Panagiotis Koumoulas
York University
Contact: pkoumoulas@gmail.com

Break-up of river ice varies from reach to reach within an individual river channel and has the ability to alter river dynamics within a short period of time. River ice break-up is often followed by rapid increases in river stage and flow velocities and has the potential to disrupt biota communities, channel morphologies, and change mixing process, which will ultimately affect water quality. Such impacts are largely caused by ice jamming, a distinctive and often extreme feature of break-up. An annual study within the East Humber River within the Kleinburg-Nobleton area was undertaken to assess the changes in sediment transport, channel stability, and flow dynamics brought about by ice jamming. Suspended sediment concentrations were acquired through the winter and spring 2008-2009.

Results show a dominant spiking trend following the downstream movement of the ice jam. Moreover, abrasion and erosion of the ice jam induced severe basal scour along the river banks, which led to bank failure along several sections of the reach. Fluctuations in discharge accounted for the downstream movement of the ice jam, as opposed to velocity, however shear stress and stream power values were quite similar year round, regardless of ice presence. Seasonal differences are not as unique as once thought, with a majority of large scale events occurring within a small window, specifically the winter-spring threshold. Modelled over a seasonal basis, channel morphology, sediment transport, flow dynamics can allow for the proper assessment of ice jam accumulation and the dynamics associated when melt is initiated at the winter-spring threshold.

1P30-0801.4 ID:3638 **16:00**

A Temporal Analysis of Spatial Trends in Channel Morphology as Influenced by Urban Land Use Change.

Amanda Brunet , *Marco Van De Wiel*
University of Western Ontario
Contact: abrunet4@uwo.ca

Urban land use modifications are widely recognized to have both significant hydrological and geomorphological implications for corresponding urban stream channels. Stream channel response to these land use changes tends to vary locally according to the magnitude of land surface change, including the removal of vegetation and the increase of impervious surface coverage. This research investigates the importance of two key modifications in catchment land area, and their influence(s) on watershed adjustment by answering the following: (1) Are trends in channel form an indication of channel response to localized riparian vegetation conditions, and (2) are these channel responses influenced by the magnitude of upstream impervious surface area? An extensive dataset of stream channel characteristics was compiled for eight subwatersheds located in the Lower Rideau River catchment of the Ottawa region. A temporal analysis, across a 63 year period (1946-2009), of the spatial trends in stream channel conditions was also conducted that compares trends exhibited by four increasingly urbanized watersheds with four that have remained in a somewhat natural state. The results from this analysis will be discussed here. Insights obtained from this study may also provide local river managers with a better understanding of the complexity of the controls acting on and influencing stream channel processes in this region, where urban populations continue to grow and the City of Ottawa continues to expand its urban periphery.

1P30-0801.5 ID:3767 **16:00**

Hydrogeomorphic setting controls calcareous fen water balance and flow paths

Tim Duval [1], *Mike Waddington* [1], *Brian Branfireun* [2]
(Presented by *Timothy Duval*)

[1] School of Geography and Earth Sciences, McMaster University
[2] Dept. of Geography, University of Toronto at Mississauga
Contact: duvaltp@mcmaster.ca

Calcareous fens are species-rich peatlands that are dependent on minertrophic water sources for wetland functioning and current conceptual models suggest the water source is ubiquitously groundwater upwelling. Here, we present evidence that calcareous fens can receive significant water from varied water sources dependant on their position in the landscape. The water balance and subsurface water flowpaths and fluxes were quantified for three calcareous fens differing in hydrogeomorphic setting over three growing seasons of vastly different precipitation inputs. The Riparian Fen received an order of magnitude more water than the Trough or Basin Fens. The Riparian Fen was dominated by stream recharge inputs and groundwater outputs. Precipitation and evaporation dominated the water balance of the Trough Fen. Only the Basin Fen received significant groundwater inputs. Variations in growing season precipitation led to subsurface flow reversals in all three fens. Subsurface water fluxes were low and groundwater did not travel appreciable distances within a growing season, due to weak hydraulic gradients and low saturated hydraulic conductivity in places. These results demonstrate the importance of landscape position, or hydrogeomorphic setting, in the hydrology of calcareous fens, and will aid in conservation, management, and restoration efforts of these important ecosystems.

1P30-0801.6 ID:3922 **16:00**

Impact of the urban heat island effect on annual streamflow patterns: Case study of Ottawa, Canada.

Jan Adamowski [1], *Kaz Adamowski* [2], *Andreas Prokoph* [3]
[1] McGill University
[2] University of Ottawa
[3] Speedstat
Contact: jan.adamowski@mcgill.ca

Large metropolitan areas in mid and high latitudes are characterized by warming air temperatures, and in particular during the winter when commercial and household heating is at its highest. In Ottawa, Canada, as in similar mid latitude continental settings, the annual spring flood is the most pronounced and annually re-occurring hydrological event. Wavelet, cross-wavelet, and trend analysis have been applied to detect, link, and quantify differences in meteorological and streamflow patterns in Ottawa and three surrounding rural areas with a special emphasis on annual changes. It was found that from ~1970 to 2000 the air temperature over Ottawa warmed at a rate of >0.035 °C/year, whereas the surrounding rural areas remained relatively stable (±0.025°C/year). The urban warming was accompanied with a significant drop in the annual temperature amplitude (i.e. less cold winters). In the same time interval, precipitation showed no significant trends in urban and rural areas, but the precipitation variability

decreased in both settings. As well, and in synchrony with the above, the streamflow trend decreased in both rural and urban areas. Wavelet analysis identified that the sub-annual and intra-annual variability has decreased (i.e. less severe short term floods) while the longer term streamflow variability increased most of the time in both rural and urban settings. In both settings, the annual streamflow amplitude was found to be significantly negatively correlated to the precipitation changes, indicating that relatively stable precipitation provides larger annual streamflow cycles (i.e. high precipitation winters and summers provide large flood events, and dry winters and wet summers provide low annual flood events). A particularly interesting finding of this research was that only the annual amplitude in the urban Rideau River streamflow in Ottawa correlated in a significantly positive way with the annual air temperature amplitude (i.e. less severe annual flooding with a decreasing winter/summer temperature contrast), whereas the rural stations did not have such a relation. In conclusion, it was determined in this study that precipitation is not affected by urban heat island warming but that it significantly influences the annual streamflow pattern. It was also determined that heat island warming (and in particular during the winter) may reduce the severity of the annual spring flood event in mid to high latitude continental settings.

1P30-0801.7 ID:3531 16:00

Monthly Precipitation over Canada Based on Satellite Estimates and Gauge Observations

Achan Lin , *Xiaolan Wang*
Environment Canada
Contact: achan.lin@ec.gc.ca

An algorithm for blending monthly satellite precipitation estimates with in-situ gauge precipitation measurements over Canada is proposed. The satellite precipitation estimates include satellite based passive microwave observations and satellite infrared data. The algorithm employs in-situ gauge data alone at area where gauge stations are dense and combines the satellite precipitation estimates and in-situ gauge measurements over area where fewer gauge stations are available. The field of satellite precipitation estimates was adjusted against the field of gridded (by ordinary kriging) gauge data before being used on the blending analysis. A preliminary assessment of the performance of this algorithm over a two year period is presented. Evaluation in the two year period in south western part of Canada shows that the new algorithm has approximately the same accuracy as what would be produced by ordinary kriging but with greater detail gained from satellite estimates. Comparison with two global precipitation products GPCP and CMAP and a Canadian precipitation product CANGRD are shown.

1P30-0801.8 ID:3791 16:00

Combinatory power of optical and radar imagery for dynamic wet area

mapping

T.s. Gala , *I.f. Creed*
(Presented by *Tekleab Gala*)
Department of Geography, University of Western Ontario, London, Ontario, Canada
Contact: tgala2@uwo.ca

In the Prairie Potholes, wet areas, which occur where the ground water table nears or intersects the ground surface, serve as major sinks and/or sources of atmospheric greenhouse gases. Despite their importance, the number and size of wet areas are not accurately known, as monitoring efforts are often limited to a single date of observation which is inadequate to capture their spatial and temporal dynamics. Remote sensing is the only approach that can provide synoptic mapping of the spatiotemporal dynamics of wet areas, however, optical and radar remote sensing techniques have demonstrated only partial utility for wet area mapping. In this study, we compare different mapping techniques, based on wet area maps produced from (1) aerial photography (scale 1:50,000) provided by government agencies, referred to as the "status quo", (2) optical (LANDSAT ETM+), (3) and a combination of optical and radar (RADARSAT-1 synthetic aperture radar. Compared to the status quo, the optical approach resulted in a 150 to 370% increase in the number of wet areas and 38 to 292% larger wet area coverage. Combining optical and radar resulted in a similar increase in the number of wet areas but 100 to 600% larger wet area coverage. The combination of data from the optical and radar images was able to improve wetland inventories by capturing a higher number and larger extents of wet areas than the currently available government agency maps. Furthermore, the time-series of wet area maps were used to derive a probability map to reveal their spatiotemporal dynamics. The power of this wet area mapping approach is that it captures wet areas under open and closed canopy conditions and it captures the response of these wet areas to changing climatic conditions in essence by creating spatiotemporally dynamic maps.

Key words: wetlands, hydrology, remote sensing, optical, radar, RADARSAT-1, and LANDSAT ETM+, prairie pothole

1P30-0801.9 ID:3803 **16:00**

Can machines learn to fill eddy flux data better than standard methods? An evaluation of artificial neural network performance

Pa Moore [1], *Pp Coulibaly* [1], *Tg Pypker* [2], *Jm Waddington* [1]
(Presented by *Paul Moore*)
[1] McMaster University
[2] Michigan Technological University
Contact: paul.moore82@gmail.com

Eddy covariance (EC) is now a commonly used method to measure ecosystem scale turbulent fluxes of mass and energy over time-scales typically ranging from several weeks to years. Having a continuous, gap free data set is desirable,

particularly when seasonal or annual values are needed for carbon and water balances. However, it is rare to have such a gap-free data set.

A variety of methods have been used to gap fill data, where the choice of method is commonly chosen based on the length of missing data. However, consensus on the best method for filling EC data is subject to debate. Care must be taken to ensure that the methods used preserve the statistical properties of the original data, and do not introduce systematic bias. This is particularly important for gap filling of CO_2 fluxes since net ecosystem exchange is the balance between small daytime and nighttime fluxes of similar magnitude and opposite direction.

The two most commonly reported methods for filling half-hour EC data are linear interpolation and mean diurnal variation. Other common methods include the use of look-up tables, energy balance closure, and empirical relations with measured environmental variables. Very little work has been done to assess the utility of new statistical models which employ machine learning for gap filling eddy covariance data.

In that regard, the focus of the poster presentation is to compare the performance of standard gap filling methods to an artificial neural network (ANN). The effect of average gap size, gap size distribution, percentage of missing data, and systematic nighttime error is evaluated. Results of non- parametric tests of significance and model performance criteria suggest that the ANN outperforms standard gap filling methods. Furthermore, the ANN has the additional advantage of having relatively low data requirements once network training has been completed.

POSTER The Past, Present, and Future of glaciers in Western North America / Glaciers de l'ouest de l'Amérique du Nord : passé, présent et futur

Room / Endroit (Terrace / Terrasse), Chair / Président (Brian Menounos), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0805.1 ID:3575 16:00

Application of Regional Climate Model output for modelling glacier mass balance in southern Coast Mountains, western Canada

Raju Aryal , Bruce Ainslie , Peter Jackson

University of Northern British Columbia
Contact: aryal@unbc.ca

Glaciers in western Canada have a distinct trend of terminus retreat and mass loss which is mainly attributed to ongoing climate warming. As a tool for climate change impact studies on glaciers, we developed a Glacier Mass Balance (GMB) model for the southern Coast Mountains of western Canada. The model is fully distributed and based on energy balance principles. The model is forced with dynamically downscaled NARR (North American Regional Reanalysis) fields where the downscaling of NARR is achieved by using RAMS (Regional Atmospheric Modeling System) meso-scale model. The GMB model has been tested at Place glacier, one of the few glaciers in the region having long term mass balance record, and others in the region over the period from 1979 to 2008. We plan to apply the model for projecting future mass balance components in response to future climate change scenarios. Ensembles of climate change scenarios obtained from different GCMs and under different emission scenarios will be used to develop ensembles of future accumulation and melt.

POSTER Geodesy and Geodynamics / Géodésie et géodynamique

Room / Endroit (Terrace / Terrasse), Chair / Président (Joseph Henton), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-0901.1 ID:3476 16:00

Ground subsidence hazard in Greater Tehran area from 2003-2007 as observed by InSAR

Samira Alipour [1], *Mahdi Motagh* [2], *Kristy Tiampo* [3]
[1] University of Western Ontario
[2] Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences
[3] university of western ontario
Contact: salipou@uwo.ca

Land surface deformation associated with groundwater overexploitation poses a serious challenge for plain aquifers of Iran. Here, we present the results of InSAR time-series analysis of groundwater-induced deformation for the period of 2003-2007 in Tehran Plain, the capital state of Iran. We constructed more than 100 interferometric displacement maps, derived from 49 Envisat ASAR data in descending and ascending geometries, and compiled an optimally accurate displacement time series from interferometric observations using a least-squares inversion technique. InSAR results detected subsidence up to about 64 cm southwest of Tehran City during 2003-2007 and up to about 20 cm during 2003-

2005 for the Varamin County to the southeast of Tehran City. Validation of InSAR time-series measurements was carried out using ground-based leveling and GPS measurements. The analysis of hydrological and geological data shows that land subsidence in Tehran is strongly related to anthropogenic processes caused by excessive groundwater extraction.

POSTER Crust to Core: Structure observations & models / AFFICHE De la croûte au noyau : observations de la structure et modèles

Room / Endroit (Terrace / Terrasse), Chair / Président (Catrina Alexandrakis and Jeff Gu), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1102.1 ID:3433 **16:00**

Precise seismic-wave velocity modeling of the outermost core

Catrina Alexandrakis , *David Eaton*
University of Calgary
Contact: alexanc@ucalgary.ca

Earth's shallow core is a region of great uncertainty relating to chemical composition. The outer core is known to be composed of liquid iron and nickel alloyed with ~10% fraction of light elements such as O, S and/or Si. Recent studies have suggested that the outermost core may have a layer enriched in light elements. Identifying such a layer could yield a better understanding of the geodynamo and thermal regime. It is possible to constrain the composition using an accurate seismic velocity model. Thermodynamic and mineral physics experiments commonly use 1-D global velocity models such as PREM, IASP91 and AK135, however these models exhibit significant velocity and density discrepancies in the outermost ~200km of the core. Here, we apply the Empirical Transfer Function method to obtain precise arrival times for SmKS waves. These teleseismic waves propagate as a whispering-gallery mode near the underside of the core-mantle boundary (CMB) and are known to be sensitive to the velocity at their bottoming point. Our dataset mainly samples the uppermost 200km of the outer core, the region with the most velocity uncertainty. Even, global coverage of CMB entry and exit points ensures velocity perturbations from lower mantle heterogeneities are effectively removed. Of the global reference models AK135, IASP91 and PREM, we find that models IASP91 and AK135 do not fit the observed data in the uppermost 200km of Earth's core. Modeling results show a

preference towards seismic velocities and depth gradients similar to PREM's in the outermost core. We propose a new, 1-D velocity model called AE09. This model has a significantly better fit to the observed data than PREM, and a smooth velocity profile that satisfies the adiabatic Adams and Williamson equation. This argues against the presence of an anomalous layer of light material near the top of the core.

1P30-1102.2 ID:3753 16:00

Crustal Structure in Greenland Using Surface Wave Group Velocities

Guillaume Joyal [1], *Fiona Darbyshire* [1], *Trine Dahl-Jensen* [2], *Tine Larsen* [2], *Peter Voss* [2], *Soren Gregersen* [2]
[1] Université du Québec à Montréal
[2] Geological Survey of Denmark and Greenland
Contact: guillaumejoyal@gmail.com

The objective of the project is to characterize the structure of the lower crust and upper lithospheric mantle across Greenland using regional earthquakes from the mid-Atlantic Ridge and northern Canada. We present maps of group velocity variation derived from Rayleigh wave dispersion curves for earthquake-station paths crossing Greenland using temporary stations operational over the last 10 years as well as the network of established permanent stations. Vertical-component data from January 1999 to May 2009 have been analyzed to compute group velocities. Rayleigh wave group velocities for periods 5 to 90 seconds have been obtained by applying a multiple filter analysis method to the fundamental mode. These group velocity dispersion curves are combined in a tomographic model to produce maps of isotropic group velocity variation. Preliminary results show that our earthquake-station dispersion curves are similar to those from previous Greenland models for certain paths, particularly at intermediate and longer periods. Group velocities at short periods are typically faster than those for continental reference models for the majority of paths studied. We present an overview of the project and maps of group velocity variation from which 3D models of the shear wave velocity structure of the lower crust and uppermost mantle will be estimated. Preliminary estimates of 1D crust and uppermost mantle structure for largely continental paths are compared to Moho depths obtained in previous studies.

1P30-1102.3 ID:4112 16:00

Crustal Structure of Hudson Bay from Ambient-Noise Tomography: Implications for basin formation

Agnieszka Pawlak , *David Eaton*
University of Calgary
Contact: aepawlak@ucalgary.ca

The Hudson Bay basin is more than 1000 km wide and contains up to 2 km of Paleozoic sedimentary rocks that overlie Archean and Proterozoic crust of the

Trans-Hudson orogen and adjacent cratonic regions. Twenty-one months of continuous ambient-noise recordings have been acquired from 37 broadband seismograph stations that encircle Hudson Bay. These stations are part of the Hudson Bay Lithospheric Experiment (HuBLE), an international project that is currently operating more than 40 broadband seismograph stations around the periphery of the Bay with the aim of improving our knowledge of crustal structure of the basin and underlying orogen, as well as to image the thick mantle root beneath the Canadian Shield. Using well-established data processing methods that included trend-removal, one-bit normalization and instrument-response correction, we obtained 591 inter-station group velocity dispersion curves from the amplitude-envelope of average daily cross-correlation functions. Data from these curves in the period range of 5-40 s provide the input for a tomographic inversion procedure developed for surface-wave analysis. Rose diagrams showing azimuthal directions of ambient noise sources are calculated and indicate strong influence from both the west coast (near southern Alaska) and the east coast (near Labrador), with no apparent influence for Hudson Bay. Rose plots disaggregated by season and period, show little variation between summer and winter, but significant dependence on period. Tomographic results show a horseshoe-like geometry of high velocity in southeastern Hudson Bay corresponding to the Archean Superior craton. A low velocity feature lies beneath the Hudson Bay basin, shrinking with period up to ~35s period. Tomographic pseudo sections are extracted from tomographic maps crossing the Bay, highlighting the low velocity feature beneath the basin. Evidence for Moho uplift (~3km) beneath the Hudson Bay basin is seen, providing the first compelling direct evidence for crustal thinning beneath the basin.

1P30-1102.4 ID:3550 16:00

Skeleton-migration in deep crustal reflection seismic profiling: Modelling, visualization and interpretation

Kris Vasudevan , *David Eaton*
University of Calgary
Contact: vasudeva@ucalgary.ca

The skeleton-migration method as we use in deep crustal reflection seismic profiling follows a two-step procedure. In the first step, we introduce a fast skeletonization of the final pre-processed stack to generate a digital catalogue containing a variety of event attributes including two-way travel times and location information in UTM co-ordinates. In the second step, we apply ray-based migration to the catalogue of events or two-way travel times of the 2-D stack using an appropriate velocity model for the crust and upper mantle. Since we do not know a priori the strike direction of the reflectors in many cases, we have implemented a fast visualization-based optimization procedure to determine the strike. In subsequent steps, we use visualization methods to view and interpret the skeleton-migration results.

For demonstration purposes, we consider examples from both the synthetic and deep crustal seismic reflection data. In all these instances, we use an elastic Kirchhoff algorithm with a shooting geometry that mimics a crooked- line in a medium of constant background velocity to generate synthetic seismograms. We apply the present skeleton-migration method for a set of trial strike directions not only to establish the functionality of the method but also affirm the model geometry from the migrated results. For a real data example, we apply the technique to deep crustal reflection seismic profile of SNORCLE (Slave-Northern Cordilleran Lithospheric Evolution Transect) line 1 to understand the Paleoproterozoic geometry of the reflectors interpreted to be a relic of the subducted slab.

1P30-1102.5 ID:4060 16:00

Shear Wave Anisotropy Beneath Central and Southern Alberta: Implications for the Western Boundary of the North American Craton

Yu Gu , *Kenny Kocon* , *Ahmet Okeler*
University of Alberta
Contact: ygu@ualberta.ca

The subsurface structure in central and southern Alberta contains information on the Precambrian tectonic development of western Laurentia and the interactions between the North American craton and Cordilleran orogen. Evidence from regional gravity, magnetic and seismic surveys have suggested major mantle seismic velocity gradients and shear wave anisotropy, overprinting a region that is juxtaposed by a broad spectrum of tectonic domains. Due to limited data coverage, however, the characteristics of mantle fabric/flow and the definition of the tectonic boundary between cratons (east/northeast) and terranes (west) remain controversial. In this study we present an improve analysis of shear wave anisotropy using recordings from the Canadian Rockies and Alberta NEtwork (CRANE), a newly installed broadband seismic array in southern-central Alberta and parts of Saskatchewan. The SKS waves show a clear northeast-southwest fast direction near the Canadian Rockies, which is consistent with the present-day absolute plate motion in western Canada. On the other hand, substantially lower splitting delay times and highly variable fast directions are observed beneath eastern-central Alberta, a region where enhanced heat-flow and below-average seismic velocities have been recently suggested. The characteristic changes in shear wave splitting direction and magnitude could signal the presence of a hidden tectonic boundary between the stable North American craton and the accreted terranes. Our measurements suggest a strong north-south oriented horizontal strain west of the Trans-Hudson orogen, which may originate from streamlined mantle flow around the edges of moving continental `keels'. Geometrical imperfections such as a divot or an abandoned plume conduit on the continental root could cause further disruptions to the mantle flow. As the result both radial and azimuthal anisotropy are likely present in the mantle beneath the Alberta basin.

POSTER Mantle Processes and Structure / AFFICHE Processus et structure du manteau

Room / Endroit (Terrace / Terrasse), Chair / Président (Julian Lowman), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1104.1 ID:3396 **16:00**

Delineating anomalous mantle in the western Superior Province

Andrew Frederiksen , *Dave Toni*
University of Manitoba
Contact: frederik@cc.umanitoba.ca

The Superior craton is the largest stable Archean region in the world. Its internal structure is complex, consisting of a series of subprovinces believed to represent accreted terranes; in the western portion of the Superior, these subprovinces form narrow east-west belts that young southwards, the craton having stabilized ca. 2.6 Ga. The western Superior is the locus of an unusual lithospheric mantle: high in P velocity, strongly anisotropic, with a consistent WSW-ESE fabric. Previous studies have located the eastern edge of the anomalous region at ca. 88 degrees W; the western and southern extent were not well constrained due to lack of instrumentation. A set of six instruments was installed in Manitoba in 2006 and 2007 by staff and students of the University of Manitoba, forming the University of Manitoba Teleseismic Array. In addition, four stations were installed in the USA to the south of the known anomaly as part of the USArray and US National Seismic Network projects. We have performed SKS splitting analysis on teleseismic earthquakes recorded by these stations, and have succeeded in outlining the southern and western limits of the anomalous mantle in a rough sense. The 1.2 second split time contour is a close match to the limits of high-velocity mantle detected by teleseismic tomography, and closes around the western Superior, indicating that the anomalous mantle is truncated in the vicinity of Lake Superior and so presumably by the Mid-Continent Rift, constraining the anomalous zone to be older than 1.1 Ga. Within Manitoba, there is a significant decrease in split time between Winnipeg and Brandon, indicating that the western boundary of anomalous mantle lies several hundred kilometres east of the Superior/Trans-Hudson boundary. The origin of the feature remains enigmatic but may be related to the initial accretion of the western Superior.

1P30-1104.2 ID:3422 **16:00**

Melt bands in a compacting porous medium: Wavelength evolution

Samuel Butler
University of Saskatchewan
Contact: sam.butler@usask.ca

When a compacting porous layer whose matrix viscosity decreases with porosity is sheared, an instability occurs that forms low and high porosity bands close to the direction of maximum compression. The bands have been proposed as high permeability conduits to rapidly transport melt from Earth's mantle to the surface in the region below mid-ocean ridges and as a mechanism for producing a low viscosity asthenosphere. A linear theory of the porosity localizing instability shows that the growth rate of the melt bands is independent of wavelength provided that the wavelength is much less than the compaction length of the material. As a result, linear theory predicts that band wavelength should remain at the wavelength at which the bands initiate which is at the grain scale of the solid material and hence bands should not be an efficient mechanism for transporting melt. However, experimental results indicate that bands are found with length scales roughly 10 times the grain scale and that the band spacing scales with the compaction length of the material. In this contribution, I will show that although the growth of the instability does not affect the band wavelength, the deformation due to the background flow causes the bands to increase significantly in wavelength and in such a way that the final band wavelength scales with the compaction length. The final wavelengths in the simulations are greater than those seen in the experiments, however.

1P30-1104.3 ID:4607 16:00

Emulating the thermal structure of spherical shell convection in plane-layer geometry calculations

Keely O'Farrell , *Julian Lowman*
University of Toronto, Canada
Contact: ofarrell@physics.utoronto.ca

Heat loss and the surface dynamics of a rocky planet are determined by the vigour of convection in the silicate mantle. However, modelling vigorous planetary scale mantle convection remains a computational challenge. Consequently, convection studies are often limited to smaller solution domains and plane layer geometries. Yet, the nondimensional mean temperature, θ, in a plane-layer geometry convecting system featuring isothermal boundaries and internal heating exceeds the mean temperature in a spherical shell characterized by the same Rayleigh number and internal heating rate. To address this geometrical effect, we implement heat sinks as a method of lowering the mean temperature in 3D Cartesian convecting systems to determine the parameters necessary for replicating the mean temperatures found in spherical shell convecting systems. We analyze the mean temperatures to derive a predictive equation for the mean temperature in a vigorously convecting fluid with a given nondimensional internal heating or cooling rate, H, Rayleigh number, Ra and

core to planet radii ratio, f. The average misfit of our parameterized equation for the observed value of θ in a fluid featuring heating or cooling from within and heating from below is less than 1.3% with a maximum disagreement of 3.3%. Using our findings, the mean temperature can be predicted to within reasonable accuracy. Moreover, the derived θ can then be used to obtain an appropriate heating or cooling rate for a plane-layer convection calculation with the same Rayleigh number so that approximately the same mean temperature is obtained in both systems. We show that at higher Ra appropriate for terrestrial mantle convection, the geotherms (i.e., mean temperature as a function of depth) of the systems are similar for vigorous convection. Our findings have important implications, in particular, for laboratory tank models of mantle convection and numerical models of mantle convection featuring temperature-dependent parameters in plane-layer geometries.

POSTER Polarimetric SAR(Synthetic Aperture Radar) Applications in Geophysics of Solid Earth and Ocean / AFFICHE Applications pour radar à synthèse d'ouverture polarimétrique destinées à la géophysique du solide terrestre et de l'océan : (séance spéciale sur RADARSAT-2)

Room / Endroit (Terrace / Terrasse), Chair / Président (Wooil M. Moon), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1105.1 ID:4082 16:00

C- AND L-BAND POLSAR SIGNAL SCATTERING STUDY OVER MIXED COVER PRAIRIE REGIONS

Hong-Jun Cai , *Wooil M. Moon*
Geophysics, The University of Manitoba
Contact: wmoon@cc.umanitoba.ca

Polarimetric SAR (PolSAR) is sensitive to the distribution and characteristics of scattering targets at the surface of Earth. Polarimetric target decomposition

theorems can separate or represent the average scattering mechanisms of scatterers, and target decomposition theories have been used for extraction of physical information from PolSAR data and in turn utilized for target classification or recognition. In this study, a comparison of polarimetric target decomposition methods and classification results of two different frequency (L- and C-band) PolSAR data over several mixed cover prairie regions. The study areas include urban areas, farm lands, and nature reserve wet lands. Fully polarimetric L-band ALOS PALSAR data (March 28th, 2009) and C-band RADARSAT-2 data in southern Manitoba are used for this study. Two areas labeled Site1 and Site2 are selected as experiment areas. The test area of Site1, composed of 900×4000 pixels, mainly includes man-made buildings, grass ground, and bituminous macadam. The test area of Site2, also composed of 900×4000 pixels, mainly includes Oak Hammock marsh, farmland, grass ground, and forest. Radarsat-2 C-band full polarimetric image is being acquired in the same area with ALOS PALSAR data. Based on the characteristics of the two different test areas, SDH decomposition and Freeman decomposition are used for test area Site1 and Site2 respectively[1][2]. The SDH decomposition can distinguish man-made target from natural target well and Freeman decomposition can describe different natural targets. In addition, the test areas are segmented based on entropy H and [3]. This study is still in progress and the variability of frequency dependence of the characteristic scattering properties of urban and natural prairie vegetation cover will further be investigated.

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POSTER Recent developments in airborne geophysics / AFFICHE Nouveautés en géophysique aérienne

Room / Endroit (Terrace / Terrasse), Chair / Président (Claire Samson), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1108.1 ID:3426 16:00

Airborne geophysics for urban planning: The case study of an airborne EM

survey (TEMPEST) for sub-surface characterization and geological mapping

Jean Lemieux , *Adam Shales*
Fugro Airborne Surveys
Contact: ashales@fugroairborne.com

In late 2008, a 20 km time domain electromagnetic and magnetic test line was flown east of Ottawa, between Metcalfe and Navan, Ontario, to investigate the nature of the conductivity response over the Gloucester Fault which forms the southern edge of a major NW-SE trending grabben filled with 500m of Paleozoic sediments. In addition to clearly resolving the two known faults that define the edges of the grabben, the resulting conductivity depth section also delineated other vertical and sub-vertical discontinuities and suggested the presence of other parallel faults within the grabben itself. These faults were not identified on the existing geological maps but would be important information to consider for regional planning and engineering purposes; especially as Ottawa continues to expand its urban footprint.

Therefore in mid 2009, a 30 x 40 km TEMPEST survey was flown over the region east of Ottawa to evaluate if high-resolution magnetic and time domain electromagnetic data can provide useful updated information on the geological structures and the character of the sub-surface rock stratification which could assist in the different aspects of regional planning and engineering. The area surveyed ran along the stretch of Highway 417 between Ottawa and Casselman; and extended approximately 5 km north and 20km south of the highway.

The resulting data and derived products are an excellent tool for characterizing the subsurface stratification east of Ottawa in terms of an updated geological and structural map including the delineation of faults, geological contacts, shear zones and lithologies. When combined and interpreted with other readily available information such as satellite imagery, it can provide useful information for urban planning.

1P30-1108.2 ID:3659 16:00

ZTEM and VTEM airborne EM applications for Gold Exploration

Jean Legault , *Vlad Kaminski* , *Harish Kumar* , *Marta Orta* , *Alexander Prikhodko*
Geotech Ltd.
Contact: jean@geotech.ca

Airborne electromagnetic methods have long been highly effective detection tools for base-metal and nickel deposits, due to their high conductivity contrast with the surrounding bedrock. Helicopter time-domain EM (HTEM) systems in particular have significantly improved penetration, sensitivity and positional accuracy that easily rival ground systems. In contrast, the physical properties normally associated with gold deposits provide significant challenges for airborne EM methods, particularly for Archean lode-gold deposits whose disseminated sulphide nature and attendant quartz-potassic-carbonate alteration cause them to be virtually undetectable electromagnetically. Yet in certain instances, vein gold deposits such as the Northern Empire Mine in the Beardmore-Geraldton region, associated with vein sulphidization and arsenopyrite replacement, have been detected using the VTEM (versatile time-domain electromagnetic) helicopter system. Still, similar examples are fewer in gold camps in the Canadian Shield.

In other areas of the world, vein gold systems are detected in HTEM as weak to moderately conductive bodies, with VTEM examples including the Nkran Mine in Ghana, associated with pyritization and arsenopyritization; and the Tusker deposit in Tanzania, associated with py-po-as sulphidization in sediments. In the Ashanti gold belt, Ghana, VTEM surveys are used as structural mapping tools for gold ore shoots hosted in graphitic shear zones along strike with the Obuasi Mine.

As the price of gold increases, other types of deposits, such as porphyries and massive sulphide bodies, are occasionally more valuable for their contained gold resources, for example the 5.1 billion tonne Pebble Porphyry deposit in Alaska and the Lalor Lake gold-copper VMS deposit in Snow Lake, Manitoba. Recent ZTEM survey results define the Pebble West and deeper Pebble East deposit to below 1.5km based on favourable resistivity contrasts with the surrounding country rocks. ZTEM results over the deeply buried (~600m) Lalor Lake orebody compare favourably with the known 900mx700m deposit geology that has escaped detection in previous airborne geophysical surveys.

1P30-1108.3 ID:3832 16:00

An aeromagnetic survey using a simulated unmanned aircraft system.

Raymond Caron [1], *Claire Samson* [1], *Stephen Ferguson* [2], *Paul Straznicky* [1], *Reed Archer* [2], *Luise Sander* [2]
[1] Carleton University
[2] Sander Geophysics Limited
Contact: rcaron@connect.carleton.ca

Carleton University in cooperation with Sander Geophysics Limited are currently building an unmanned aircraft system (UAS) for use in aeromagnetic surveying. The UAS will feature non-magnetic composite materials, a horizontal gradiometer with cesium magnetometers, and an autonomous operation system with autopilot and obstacle avoidance. The use of a UAS in aeromagnetic surveying has an immediate benefit over conventional aircraft due to its lower altitude flight capability which will allow Earth’s magnetic field to be recorded at a higher resolution.

As an early test of the performance of some of the UAS components, most importantly the magnetometers and data acquisition system, a simulated UAS was built. The simulated UAS is a T-shaped structure with the wingspan of the

UAS. It is configured as a horizontal gradiometer with the cesium magnetometers spaced 4.9m apart.

In February 2010, the simulated UAS was tested over a study site located within the Central Metasedimentary Belt of the Grenville Province in Ontario. This site was chosen due to the presence of several linear strong magnetic gradients that can be easily correlated with geology. It features a vertical similar fold of strongly magnetic metavolcanic rocks contacting weakly magnetic calcite marble. The survey was flown at an altitude of 84m with the simulated UAS suspended 34m beneath the helicopter. The survey was flown at 50m line spacing with 300m control line spacing.

Data sets from a high resolution ground magnetic survey, and from a lower resolution conventional aeromagnetic survey is used to analyze the results obtained using the simulated UAS. Comparison of the three independent data sets allow the resolution capability and performance of the simulated UAS to be assessed.

POSTER Geophysics in sensitive environmental sites / AFFICHE Géophysique dans les sites écologiquement vulnérables

Room / Endroit (Terrace / Terrasse), Chair / Président (Claire Samson), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1109.1 ID:3306 16:00

Evaluating the health and environmental impact of Marun oil-field brines of SW Iran

Hassan Mirnejad [1], *Hossein Mohammadzadeh* [2], *Vahid Sisakht* [3]
[1] Department of Geology, Faculty of Science, University of Tehran, Tehran, Iran.
[2] Groundwater Research Center, Faculty of Science, Ferdowsi University of Mashhad, Mashhad, Iran.
[3] Department of Geology, Faculty of Science, University of Tehran, Teharn, Iran.
Contact: hmirnejad@hotmail.com

Oil-filed brines which are normally separated from natural oil and gas are either injected into the producion wells or directed into evaporation pools. In the latter case, it is possible that the leakage of brines into the urrounding areas affects the underlying aquifers and strata. We report for the first time a complete set of trace element contents of brines from Marun oil-field in SW Iran. Geochemical analyses of the Marun brines show that while contents of some elements (e.g., Cd: 0.0005 mg/lit; Pb: 0.02 mg/lit; As: 1.13 mg/lit; Se: 0.03 mg/lit) are too low to allow considerable contamination of the surrounding areas and thus fall below the level of Extraction Procedure Toxicity defined by the U. S. Environmental Protection, the high levels of Cl (134100 mg/lit) and Na (65400 mg/lit) in the brines can affect the farming lands and groundwater.

POSTER Insights into seismic hazard / AFFICHE Risques sismiques

Room / Endroit (Terrace / Terrasse), Chair / Président (Kristy Tiampo), Date (01/06/2010), Time / Heure (16:00 - 18:00)

1P30-1110.1 ID:3695 16:00

Engineering Seismology Toolbox

Karen Assatourians , *Gail M. Atkinson*
The University of Western Ontario
Contact: kassatou@uwo.ca

Accurate, consistent and effective seismic hazard evaluation is a prerequisite for hazard reduction and mitigation efforts. The Engineering Seismology Toolbox (www.seismotoolbox.ca) provides Canadian researchers and practitioners in seismic hazard evaluation, design, and mitigation techniques with useful tools in the following areas: 1-Probabilistic Seismic Hazard Software. 2-Database of ground-motion time histories for engineering analyses. 3-Interpretation of seismic hazard results for geotechnical applications. 4-Research ground-motion database and simulations for earthquakes in Canada. In this presentation we focus on the research ground-motion database that has been compiled; it is comprised of thousands of records of earthquakes across Canada in the magnitude range from 3.5 to 6, at distances from 10’s to 100’s of km. These records facilitate quantitative analysis of earthquake source and propagation characteristics

1P30-1110.2 ID:3702 16:00

Development of composite catalogue for earthquake hazard assessment in major Canadian cities

Azadeh Fereydouni , *Miguel Macias* , *Katsu Goda* , *Gail Atkinson*
University of Western Ontario
Contact: afereydo@uwo.ca

The development of a comprehensive, high-quality catalogue of earthquake events is the most fundamental step in seismic hazard analyses and related studies. It is necessary to combine information from several data sources and types to develop a complete and reliable catalogue. We have developed a composite Canadian seismicity catalogue, with events through 2009 (CCSC09), suitable for seismic hazard analyses of major Canadian cities. The CCSC09 catalogue is based on the most updated version of the Seismic Hazard Earthquake Epicenter File of the Geological Survey of Canada (SHEEF2008), enhanced using other national and international databases. A semi-automatic procedure is applied to discriminate and eliminate duplicate events and replicated information in the primary dataset. Location, magnitude and focal depth parameters are then revised by the addition of available complementary data from other sources. The SHEEF catalogue is supplemented near Canada's southern border using U.S. data sources. For each event, a mix of magnitude types including mb, MN, ML, Ms, Mc and moment magnitude are compiled, and a preferred magnitude is assigned depending on availability and quality of data. All magnitude measures are retained in the CCSC09 to provide the most complete event characterization; a preferred conversion to moment magnitude is provided, along with an estimate of its uncertainty. The CCSC09 provides an essential baseline for earthquake hazard analysis of major Canadian cities.

1P30-1110.3 ID:3795 16:00

Scenario ShakeMaps for Ottawa region considering frequency dependent soil amplification factors

Jalpa Pal , *Gail M. Atkinson*
The University of Western Ontario
Contact: jpal3@uwo.ca

Near surface geology plays a very important role in earthquake ground shaking and its dependence on frequency. The degree of amplification depends on the shear-wave velocity of the soil layer and its contrast with underlying bedrock, while the frequency content is determined by soil depth. Reliable amplification factors accounting for such effects are vital for earthquake hazard assessment. This study employs the quarter wavelength method to generate frequency dependent linear amplification factors for the Ottawa region using recent data from approximately 22000 soil profiles. To include the effects of nonlinearity of ground shaking, frequency dependent nonlinear reduction factors were applied to the linear amplification factors. The resultant amplification factors were used to generate scenario ShakeMaps to study the expected ground-shaking intensity distribution patterns for input motions having a 2%/50 year exceedence probability, as based on the National Building Code seismic hazard model. Furthermore, the impact of location for an actual scenario event (a given magnitude at a specific location) was tested by considering the occurrence of such a scenario in various locations in the Ottawa region. Maximum ground motions occur when a scenario event occurs near the deep soft sediments in the Orleans area.

1P30-1110.4 ID:3919 **16:00**

Insights into ground-motion processes and hazards from study of earthquake records in Japan

Hadi Ghofrani , *Gail Atkinson*
University of western Ontario
Contact: ghofrani_hadi@yahoo.com

We use a large database (>10,000 records) of ground motions in Japan to explore earthquake processes including attenuation, magnitude scaling, site effects and other factors such as event type and focal depth, for events with moment magnitude M ≥ 5.5. Regression analysis and statistical analysis are implemented to characterize, and distinguish between, different types of earthquake ground motion processes including those for crustal, in-slab and interface events (for both source characterization and attenuation). We explore site effects, and their nonlinearity, by implementing Vs30 directly into ground motion prediction equations (GMPEs) as a predictive variable. In addition to Vs30, the effect of depth to the bedrock is investigated. It is important to understand potential differences in ground-motion generation and propagation between event types within this active subduction environment to adequately assess seismic hazard. This also facilitates comparison of ground motions across regions, to better understand regional variations in ground motion processes. Regressions on vertical and horizontal components are performed separately, to determine whether the H/V ratio is consistent with the implications of separate regressions.

1P30-1110.5 ID:3962 **16:00**

Crustal Stress Indicators for Southwest British Columbia: What controls faulting in the crust?

Natalie Balfour [1], *John Cassidy* [2], *Stan Dosso* [1]
[1] University of Victoria
[2] Geological Survey of Canada
Contact: jcassidy@nrcan.gc.ca

We present new stress and anisotropy results, which are combined with seismicity, local tectonics, and GPS data (velocity and strain) to determine regional stresses that control faulting in the North American crust above the Cascadia subduction zone in SW British Columbia (BC). The region experiences crustal earthquakes with recorded magnitudes up to 7.3. These events have a shorter reoccurrence interval than megathrust earthquakes and pose a significant hazard to major population centers. The North American plate in this region includes a change in margin orientation from N-S in Washington State to NW-SE in BC and involves a complex region of deformation above a bend in the subducting Juan de Fuca plate. Over 1000 focal mechanisms have been calculated to identify the dominant style of faulting and inverted to estimate the 3

principal stress orientations and stress ratio. These results are then compared with results from recent anisotropy work where over 4000 station-event pairs have been analysed for shear-wave splitting. By comparing stress orientations with fast directions we investigate whether the source of anisotropy is stress or structure related and identify any variations in the stress field. Preliminary results indicate a change in fast direction with distance from the trench from margin-parallel on Vancouver Island to margin-normal on Mainland BC. This change is also reflected in GPS velocity vectors and may suggest there is some variation in the stress with distance from the margin.

1P30-1110.6 ID:3819 **16:00**

Study of strong motion and early warning in Strait of Hormuz,Southern Iran

Attiehe Eshaghi , *Kristy Tiampo*
University of Western Ontario
Contact: aeshaghi@uwo.ca

The goal of earthquake early warning is to reduce the damaging affects of earthquakes by giving a few seconds to a few tens of seconds warning before the arrival of damaging ground motion. Using P-wave arrivals is the most rapid method of delivering earthquake early warning and may permit a few seconds warning of ongoing ground motion in the region. To rapidly assess the potential for damage of an earthquake for purposes of earthquake early warning in southern Iran, we determined a ground-motion period parameter τc. We selected earthquakes with that have been recorded during 1975-2006 by near field strong motion instruments in the region, operated by Building and Housing Research Center. The vertical components of accelerations were converted to ground velocity and displacement. The displacements are filtered with a one-way Butterworth high-pass filter with a cut-off frequency of 0.075 Hz. We found the relationship between τc and magnitude (M), for southern Iran. This relationship can be used to detect the occurrence of a major earthquake and provide onsite warning in the area around the station within seconds after the arrival of the P wave. Also with using of Fortran program EXSIM we generate synthetic records based on Khurgo earthquake scenario. Then with the synthetic records the strong-motion map (PGA and PGV) as a function of time from 10 sec to 60 sec after the first P-wave trigger were generated which can be used for rapid response purposes.

1P30-1110.7 ID:3715 **16:00**

Seismicity model for the seismic hazard mapping of Croatia

Marijan Herak , *Davorka Herak*
Department of Geophysics, Faculty of Science, University of Zagreb
Contact: herak@irb.hr

A new seismicity model is proposed as the basis for the update of PSH mapping of Croatia. Although all available information on the position or the activity of

seismogenic faults was considered, due to complicated tectonic framework and scarce on non-existent knowledge of the recent moment-rate release on major faults, the analyses primarily relies on the past seismicity as cataloged in the Croatian Earthquake Catalog. It lists over 35000 earthquakes in Croatia and the neighboring regions in the period BC–2009. A discretized, smoothed seismicity approach is used, as it was shown that no zoning can provide reasonably uniform distribution of all recurrence parameters (*a*- and *b*-values and *Mmax* in the frequency-magnitude relation) within delineated areal source zones. An algorithm to map spatial distribution of *a* and *b* consisted of 6 steps: 1) division of the investigated area into a regular grid of cells (5.5 x 5.5 km); 2) investigation of the catalog completeness interval for a predefined suite of magnitude thresholds in a circle of 100 km radius around each of the grid-cells; 3) computation of the maximum-likelihood estimates for a and b, for events within circles of variable radius, holding at least *Nmin* events and centered at each grid-cell, using previously estimated completeness thresholds; 4) delineation of source-zones within which a constant *Mmax* is assumed (mostly around known active faults, but also in zones of diffuse seismicity); 5) assignment of Mmax to each of the zones, based on their seismic history and the length of active fault-segments (if available). Slightly smoothed spatial distributions of the recurrence parameters *a*, *b*, and *Mmax* thus obtained, were then used to generate a synthetic earthquake catalog for a period of 5 million years. Its statistical analyses yielded preliminary versions of hazard maps to be incorporated into the Croatian National Annex for Eurocode-8.

1P30-1110.8 ID:3978 16:00

Pattern Informatics in Mining Induced Seismicity and its Applications to Rockburst Hazard Assessment

Nelson Cho [1], *Kristy Tiampo* [1], *Stephen Mckinnon* [2], *Javier Vallejos* [2], *John Rundle* [3], *William Klein* [4]
[1] University of Western Ontario
[2] Queen's University
[3] University of Southern California
[4] Boston University
Contact: ncho3@uwo.ca

The Pattern Informatics (PI) (Rundle et al., 2002; Tiampo et al., 2002) was applied to mining induced seismicity from two mines in Ontario-Canada to estimate regions prone to rockburst hazard. To determine the optimal parameters of the PI, features such as the completeness of the catalog and effective ergodicity were analyzed. The latter was assessed using the Thirumalai-Mountain (TM) fluctuation metric (Thirumalai and Mountain, 1989) in order to determine the spatial/temporal discretization in which the system is considered stationary and in a state of metastable equilibrium. Retrospective forecasts were made to test the PI and these results are compared to relative intensity (RI) maps (Holliday et al., 2006) using the Heidke skill score (Heidke, 1926). It was found that overall the PI outperforms the RI in most cases, with some instances of time

in which both the PI and RI display poor performances. The greater discrepancies between the methods are identified during effective ergodic periods. Both the occurrence of these effective ergodic periods and the instances in which the efficiency of both methods is extremely low are dictated by the blasting regime in the mine.

Plenary Day 2 / Plénière jour 2

Room / Endroit (Ballrooms ABC), Chair / Président (Bill Crawford and Spiros Pagiatakis), Date (02/06/2010), Time / Heure (08:30 - 10:00)

P2.1 ID:3369 INVITED/INVITÉ 08:30

Argo: A decade of success, what have we learned and what comes next?

Howard Freeland
DFO Science-Pacific Region
Contact: howard.freeland@dfo-mpo.gc.ca

Argo is presently tracking more than 3300 floats reporting data every 10 days from every ocean basin. The technical objective was to make data freely available in near real-time describing the climate status of the oceans, globally, and we are almost achieving this objective. Currently 90% of all profiles are available for download from the Global Argo Data Centres within 24 hours of acquisition.

The scientific purposes for doing Argo were to detect climate variability on seasonal to decadal time-scales and to provide data for initialization and constraint of climate models. The targeted variability included changes in the large-scale distribution of temperature and salinity and in the transport of these properties by large-scale ocean circulation

I will review the experience gained as we built a global ocean climate observatory. Ten years after Argo was launched, we do have the global array in place and use of the array is growing rapidly. A delayed-mode quality control system was promised and is working well, but some challenges remain and these will be described. We promised global access, and while this is available in principle, practically many scientists in developing nations have weak access to high-speed internet and so find the task of downloading many large files to be an overwhelming challenge.

The availability of a global real-time dataset that describes the changing internal structure of the oceans is profoundly changing the way oceanography is being done, I will outline some of the striking observations of the ocean that are being reported and analysed now and were not possible 10 years ago. Many nations are investing substantial resources in the development of coupled atmosphere/ocean assimilation models and progress will be reviewed. Data retention experiments are being run to show the relative impact on forecast skill by adding or removing Argo observations, satellite altimetry and the equatorial mooring arrays. Results show that though no observing system is redundant Argo is important in all ocean regions and in some regions is the only observing system that adds skill.

At the OceanObs'09 meeting there were many proposals to "improve" Argo and some have already been adopted, some make sense and likely will be adopted, and some will not be adopted for reasons technical, financial or political. It is clear that as Argo enters its second decade it will change; I will outline my own opinion of how Argo is likely to evolve over the next 5 years.

P2.2 ID:3341 INVITED/INVITÉ 09:15

From seismological science to saving lives – one path from science to societal relevance

John Adams
Geological Survey of Canada
Contact: jadams@nrcan.gc.ca

A national seismic hazard map implemented into a national building code is the most effective way that we can reduce deaths and economic losses from future earthquakes. The goal of the seismic provisions of a building code is to ensure the life-safety by preventing building collapse during damaging earthquakes and to ensure the continued use of the emergency buildings like fire stations and hospitals that will be needed afterwards. Those performance goals are intended to be the same for all Canadians (whether living in high or low seismicity regions), so the code needs to be fair in distributing the cost in proportion to the benefits, cost-effective in achieving the performance goals, and the code requirements should be "as simple as possible, as complicated as necessary" (to aid in implementation and compliance). A fair map requires a good assessment of the science (seismology).

The Government of Canada has been involved in earthquake monitoring for over a hundred years. The results of this long-term commitment to basic data collection – including running seismographs and strong motion instruments, collecting felt information and assembling information about historical earthquakes, as well as basic research about the nature and origins of Canada's earthquakes – have been the basis for the four past seismic hazard maps.

To improve, the seismic hazard estimates need to evolve with time as scientific understanding grows, adjust in probability level as societal acceptance of risk levels changes, change in a steady fashion from code cycle to cycle (not be subject to wide swings in the estimates), and finally be reliable (an accurate estimate of the true hazard). These challenges can best be met by an iterative process of continual code improvement involving many players. While increases in code requirements may be resisted, these may be required to attain the expected performance (life-safety) or may be justified on economic grounds (present cost versus future loss). To achieve the best result, a “decision snake” is necessary: the scientist must convince the engineer, the engineer must convince the administrators/lawmakers, the lawmakers must convince the builders, and the builders must convince the Canadian public to pay for more earthquake-resistant buildings. Canadians are best able to participate in the decision snake when they understand both the hazard and the risks. Therefore the scientist needs to communicate earthquake hazard to the general public so that there is a good appreciation that the short-term costs will ultimately save lives, save money and reduce human misery.

Lawrence Mysak Session on Ocean and Climate Dynamics (Part 3) / Séance Lawrence Mysak sur la dynamique des océans et du climat (Partie 3)

Room / Endroit (Richelieu), Chair / Président (M.J. Bowman), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B04.1 ID:4043 **10:30**

TSA for Representation of Nonlinear Energy Transfer in a Wind Wave Spectrum: The Relation between Nonlinear Fluxes and Spectral Wave Shape

Will Perrie [1], *Don Resio* [2]
[1] Bedford Institute of Oceanography
[2] ERDC-Coastal and Hydraulics Lab, USA
Contact: perriew@dfo-mpo.gc.ca

We present TSA (two-scale approximation) as a new method for estimating nonlinear transfer rates in wind waves, based on the full Boltzman integral (FBI) for quadruplet wave-wave interactions and we test this new method for idealized and real spectral data. Here, we focus on comparisons of the TSA and the Discrete Interaction Approximation (DIA) to the FBI for observed wave spectral from field measurements. Observed wave spectra are taken from a wave gage array in Currituck Sound and a directional waverider off the coast near the Field Research Facilty (FRF) at Duck, North Carolina. Results show that the TSA compares much more favorably with the FBI than the DIA, even for cases in

which the parametric component of the formulation does not capture the spectral energy distribution very well. These results remain valid for the TSA estimates when the FBI results are significantly affected by the directional distribution of energy. We also show that although nonlinear transfers are substantially weaker in swell portions of the spectrum, these interactions contribute significantly to the spectral evolution and net energy balance in long-distance swell propagation.

2B04.2 ID:4610 10:45

Recent Developments in Ocean Remote Sensing with SAR

William Perrie , *Tao Xie* , *Biao Zhang*
Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

Fine-resolution measurements of near-surface wind speed and direction over the Gulf Stream region of the Northwest Atlantic were made using synthetic aperture radar (SAR) images collected by RADARSAT-2. These observations reveal the existence of small–scale surface features in the curl and divergence fields of the wind stress. Moreover, sea surface temperature front features, as suggested by corresponding AVHRR and MODIS images, are evident in both of the wind stress curl and divergence fields. The Gulf Stream signature is particularly evident in the curl of the wind stress. The importance of this methodology is that SAR can penetrate clouds.

2B04.3 ID:4021 11:00

Machine learning methods for studying the environment

William Hsieh
(Presented by *W. Hsieh*)
Dept. of Earth and Ocean Sciences, University of British Columbia, Vancouver, BC
Contact: whsieh@eos.ubc.ca

Machine learning methods (e.g. artificial neural networks) originated from the field of computational intelligence (i.e. artificial intelligence), with their main objective being the extraction of information from data using computational methods. They allow the nonlinear generalization of many classical statistical methods for classification, regression, principal component analysis, canonical correlation analysis, etc. In this presentation, we will illustrate the differences between machine learning and statistics, and how machine learning methods can be applied to various phenomena in the hydrosphere, atmosphere and cryosphere.

2B04.4 ID:3544 11:15

Influence of joint modes of atmosphere/sea ice variability on Fram Strait ice flux

Joel Finnis [1], *William Hsieh* [2]

[1] Memorial University of Newfoundland
[2] University of British Columbia
Contact: jfinnis@mun.ca

Wind-driven flushing of sea ice through Fram Strait has been proposed as a key contributor to Arctic sea ice loss since the 1970s, reducing the volume of multi-year ice and increasing vulnerability of ice cover to climate change. Several large-scale modes of atmospheric variability of have been associated to this flow. Most notable are proposed links with the Arctic Oscillation (AO) and the Arctic Dipole Anomaly (DA), respectively defined as the first and second principal components of northern hemisphere sea level pressure. However, it remains uncertain whether these patterns exert a robust influence on ice extent, and the influence of the AO in particular appears to vary over time. Part of the difficulty may be the use of patterns defined using atmospheric data alone, which are subsequently related to ice extent and motion. An alternate approach is to identify joint modes of atmosphere and ice variability, ensuring the use of atmospheric patterns with a direct link to Fram Strait flux. This is accomplished here using canonical correlation analysis (CCA) and a nonlinear CCA equivalent based on neural network modelling (NLCCA), which are used to connect large (hemispheric) scale atmospheric variability with ice motion across Fram Strait and within the Eastern Arctic. Both CCA and NLCCA are more likely to accurately capture local and nonlocal influences on Fram Strait flow than atmosphere-only analysis, providing new insight into physical mechanisms driving ice loss and a complement to previous studies. Advantages of the nonlinear method are discussed, and relationships between joint modes and trends in ice extent are examined. Results provide the basis for future research on forecasting ice conditions.

2B04.5 ID:4031 11:30

Links Between the Deep Western Boundary Current, Labrador Sea Water Formation and Export, and the Meridional Overturning Circulation

Paul Myers , *Nilgun Kulan*
Department of Earth and Atmospheric Sciences, University of Alberta
Contact: pmyers@ualberta.ca

Based on an isopyncal analysis of historical data, 3-year overlapping triad fields of objectively analysed temperature and salinity are produced for the Labrador Sea, covering 1949-1999. These fields are then used to spectrally nudge an eddy-permitting ocean general circulation model of the sub-polar gyre, otherwise forced by inter-annually varying surface forcing based upon the Coordinated Ocean Reference Experiment (CORE). High frequency output from the reanalysis is used to examine Labrador Sea Water formation and its export. A number of different apprpoaches are used to estimate Labrador Sea Water formation, including an instanteous kinematic approach to calculate the annual rate of water mass subduction at a given density range. Historical transports are computed along sections at 53 and 56N for several different water masses for

comparison with recent observations. The variability of the strength of the meridional overturning circulation (MOC) from the reanalysis is also examined in both depth and density space. Linkages between MOC variability and water mass formation variability is considered.

2B04.6 ID:4089 **11:45**

Temperature and Salinity Variability of the Deep Western Boundary Flows in the Northwest Atlantic

John Loder [1], *Igor Yashayaev* [1], *Eugene Colbourne* [2], *Shane Elipot* [3], *Yuri Geshelin* [1], *Ed Horne* [1], *Chris Hughes* [3], *Miguel Maqueda* [3]
[1] Fisheries and Oceans Canada, Bedford Institute of Oceanography
[2] Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre
[3] National Oceanography Laboratory
Contact: John.Loder@dfo-mpo.gc.ca

The “deep western boundary currents” flowing equatorward along the North Atlantic’s western margin are an important component of the Atlantic Meridional Overturning Circulation (AMOC) and hence of the global climate system. After exiting the southern Labrador Sea, they encounter complex topography as they flow past Orphan Knoll and around Flemish Cap and then the Tail of the Grand Bank. Drifter, hydrographic, moored and tracer data provide information on the fate and integrity of the flows as they move to lower latitudes, but important questions remain regarding their variability. Recent variability in the properties of the slope and deep flows between the Labrador Sea and the Scotian Rise will be described using observational data from several programs. These include an annual survey across the Labrador Sea and semi-annual cross-slope surveys as part of ongoing Fisheries and Oceans Canada (DFO) monitoring programs, a 6-year DFO mooring program across Orphan Basin, and recent moored and hydrographic observations over the Scotian Slope and Rise from the UK RAPID program. The variability will be interpreted in relation to deep-water variability documented previously in upstream subpolar basins. It appears that the 2004 cold fresh anomaly in Denmark Strait overflow water reached the Scotian Rise as a weak signal in 2007-08, suggesting a 3-4 year transit time with considerable water mass modification.

Stratospheric Processes and their Role in Climate (Part 3) / Les processus stratosphériques et leur incidence sur le climat (Partie 3)

Room / Endroit (Frontenac), Chair / Président (N. McFarlane), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B05.1 ID:4062 INVITED/INVITÉ 10:30

Stratospheric and upper tropospheric changes caused by geoengineering aerosols

Thomas Peter [1], *Patricia Heckendorn* [1], *Debra Weisenstein* [2], *Beiping Luo* [1], *Eugene Rozanov* [3], *Stephan Fueglistaler* [4], *Larry Thomason* [5], *Ana Cirisan* [1], *Peter Spichtinger* [1]
[1] ETH Zurich, Switzerland
[2] AER, Lexington MA, USA
[3] PMOD-WRC, Davos, Switzerland
[4] DAMTP, U. of Cambridge, UK
[5] NASA Langley Research Center, Hampton, VA, USA
Contact: thomas.peter@env.ethz.ch

One of the most prominent geoengineering ideas is to increase the Earth's albedo by artificially enhancing stratospheric sulphate aerosols. We use a 3D chemistry climate model, fed by aerosol size distributions from a zonal mean aerosol model, to simulate continuous injection of 1–10 Mt/a sulphur in the form of SO2 into the lower tropical stratosphere. We find that the volcanic and geoengineering forcings differ in terms of their radiative, chemical and dynamical impacts on climate, mainly because the continuous supply of sulphuric acid and hence freshly nucleated aerosol particles from geoengineering enhance the formation of large particles by coagulation. This causes a non-linear relationship between annual sulphur input and stratospheric sulphur burden, revealing the importance of properly investigating the microphysics of the sulphate aerosols. The growth of the particles is sensitive to the injection region and the SO2 amount per injection time. The formation of large particles leads to notable disadvantages. Larger particles are less efficient in cooling than small particles with the same total mass. Furthermore, they are lost more rapidly by gravitational settling and subsequent tropospheric washout, thus larger sulphur amounts are needed to achieve a targeted cooling. The largest particles may sediment into the tropical tropopause region and cause in situ heating; as a consequence the entry mixing ratio of water vapour into the stratosphere increases. We show that this may have significant impact on total ozone, because the increased water vapour intensifies the HOx-induced ozone loss cycle. Also, the stratospheric circulation is affected by the strong heating of the lower stratosphere, intensifying the polar vortices, the formation of polar stratospheric clouds and polar ozone depletion. Finally, our results suggest that the sulphuric acid particles may act as preferable cirrus cloud nuclei upon re-entry into the troposphere, thus possibly affecting global cirrus cloudiness.

2B05.2 ID:3657 11:00

Evidence for Stratospheric Circulation Changes Over the Past Three Decades From Multiple Measurement Sources

Eric Ray [1], *Fred Moore* [1], *Karen Rosenlof* [1], *Sean Davis* [1], *Harald Boenisch* [2]
[1] NOAA/ESRL
[2] Goethe Universitat Frankfurt
Contact: eric.ray@noaa.gov

Indicators of stratospheric zonal mean circulation changes based on observations have been difficult to attain due to a lack of sufficient long-term stratospheric measurements. Several such datasets do exist and each of them suggests that changes have occurred in the strength of the stratospheric circulation over the last 30 years. We show that the changes seen in the measured or measurement-based indicators of stratospheric circulation, mean age of air from SF6 and CO2, TOMS/SBUV total ozone and residual circulation calculations, are consistent with one another. We use a simple model of the stratosphere, the tropical leaky pipe model, to estimate the scale and vertical structure of circulation and mixing changes that can result in the observed stratospheric trace gas changes on both the short-term, several year time scale and the long-term, 30 year time scale. Comparisons of the long-term changes in the stratospheric circulation suggested by the measurements with those from global chemistry-climate model simulations reveal substantial differences.

2B05.3 ID:3930 11:15

Simulation of a realistic quasi-biennial oscillation in an atmospheric general circulation model

James Anstey [1], *John Scinocca* [1], *Martin Keller* [2]
[1] Canadian Centre for Climate Modelling and Analysis
[2] University of Toronto
Contact: james.anstey2@gmail.com

The quasi-biennial oscillation (QBO) in tropical stratospheric winds is a major feature of the stratospheric circulation, impacting interannual variability at both tropical and extratropical latitudes. Simulation of the QBO in atmospheric general circulation models (AGCMs) will allow such models to better represent natural climate variability on decadal timescales. Unfortunately the QBO is absent from most AGCMs, and there remains significant observational uncertainty regarding the relative quantitative importance of the various types of tropical waves that contribute to forcing the QBO. Using a stratosphere-resolving AGCM, the Canadian Middle Atmosphere Model (CMAM), we simulate a realistic QBO and examine the wave forcing by both resolved and parameterized waves that gives rise to the QBO in our model. AGCMs that simulate QBO-like tropical wind oscillations generally do so by using fine vertical resolution, such as 0.5 km, that allows them to explicitly represent the dynamics of tropical waves with small vertical wavelengths, and we consider in some detail the reasons why this increase in vertical resolution is required to simulate the QBO.

2B05.4 ID:3703 11:30

Transient tropospheric forcing of sudden stratospheric warmings

Jeremiah Sjoberg , *Thomas Birner*
Department of Atmospheric Science, Colorado State University
Contact: thomas@atmos.colostate.edu

The amplitude of tropospherically forced planetary waves is known to be of first-order importance in producing sudden stratospheric warmings. This forcing amplitude is observed to undergo strong temporal fluctuations. The characteristics of the resulting transient forcing leading to major stratospheric warmings are investigated in a highly truncated [zero dimensional] version of the Holton-Mass model of stratospheric wave-mean flow interaction as well as the full [one dimensional] Holton-Mass model. Transient momentum forcing due to quasi-random gravity wave activity is also taken into account by means of an additive noise term in the zonal momentum equation. Time dependent tropospheric planetary wave amplitudes as derived from the ERA-40 and ERA Interim datasets as well as idealized time dependent tropospheric forcing are utilized to drive these simple models. Initial analysis suggests that major warmings are preceded by a reduction in the transience of the tropospheric wave forcing.

2B05.5 ID:3656 11:45

The Influence of Sea Surface Temperature Variability on the Antarctic Stratosphere.

Isla Simpson , *Theodore Shepherd*
University of Toronto
Contact: isla@atmosp.physics.utoronto.ca

An ensemble of chemistry climate model (CCM) simulations has been examined for evidence of an influence of sea surface temperature (SST) variability on Antarctic stratospheric dynamics and ozone concentrations.

In the Canadian middle atmosphere model (CMAM) it is found that pre-1980's ozone trends differ significantly between simulations that use observed SSTs and those that use modelled SSTs. There is a lack of ozone depletion in the mid-1970's in the simulations with observed SSTs at the lower boundary as in the observations. Furthermore, in the CMAM there is evidence that during La Nina years there is a tendency for an anomalously warmer polar stratosphere with higher ozone concentrations. Thus, this lack of ozone depletion in the mid-1970's in simulations forced with observed SSTs could be associated with the prevalence of La Nina conditions at that time.

The statistical robustness of this signal, and the extent to which it is present in other CCMs, is examined.

Coupled Atmosphere-Ocean Prediction and Predictability (Part 3) / Prévision et prévisibilité avec modèles couplés atmosphère-océan (Partie 3)

Room / Endroit (Joliet), Chair / Président (Keith R. Thompson), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B06.1 ID:3846 10:30

Mesoscale variability in the Labrador Sea – a model study

Jieshun Zhu , *Entcho Demirov*
Department of Physics and Physical Oceanography, Memorial Univeristy of Newfoundland
Contact: jszhu@mun.ca

Previous studies demonstrated that the mesoscale eddies play an important role in the dynamics of the Labrador Sea. In this work, we study the mesoscale variability of the Labrador Sea and its impact on the deep convection, LSW formation and spreading. The numerical model is NEMO/LIM2 with a horizontal resolution of 1/12º in the Labrador Sea. The effects of the mesoscale eddies are quantified through comparison with simulations with a coarser resolution eddy-permitting model. Some preliminary results from a higher resolutions (1/16º) interannual (1987-2005) experiment are also discussed.

2B06.2 ID:3851 10:45

The mean surface circulation of the western North Atlantic subpolar gyre: Model validation using drifter observations and a new geodetically-determined mean sea surface topography

Simon Higginson [1], *Keith Thompson* [1], *Marc Véronneau* [2], *Dan Wright* [3], *Jianliang Huang* [2]
[1] Dalhousie University
[2] Geodetic Survey Division, Natural Resources Canada
[3] Bedford Institute of Oceanography
Contact: simon.higginson@dal.ca

The currents of the North Atlantic subpolar gyre provide an important pathway for the transport of cold, fresh water from high latitudes towards the equator. Melting of the Greenland ice sheet will increase the volume of fresh water entering the gyre and understanding the circulation will be important in projecting the regional and global effects of climate change. It is important that models accurately represent the circulation in this region. As part of the GOAPP research network,

the NEMO ocean model is being applied to this region using new developments in spectral nudging. In this study we use a new estimate of the mean sea surface topography (MSST), derived from satellite and terrestrial gravity measurements and satellite altimeter measurements, to estimate the mean surface circulation of the subpolar gyre. We compare this estimate with previous geodetic estimates of MSST, with direct oceanographic estimates of the circulation derived from the movement of surface drifters over more than 20 years and with results from the NEMO ocean model. We show that the new MSST gives improved resolution of the currents along the coasts of Greenland and Labrador compared with earlier geodetic MSSTs. We also find good agreement with the oceanographic observations. Comparison with the NEMO model shows unprecedented agreement on the direction and speed of the main boundary flows. We conclude with a discussion of the differences between the oceanographic and geodetic estimates of circulation.

2B06.3 ID:3579 11:00

Estimating Model Errors in an Ensemble Kalman Filter Assimilation System of Argo profiles for the Pacific Ocean

Ziwang Deng
Environmental Science and Engineering,UNBC
Contact: ldxd101@yahoo.com

Model errors including model bias and system noise are non- negligible in oceanic models, which must be accounted for in oceanic data asimilation. In this study, several methods to estimate model bias and system noise are investigated in the framework of Ensemble Kalman filter assimilation system. Argo profiles over the Pacific Ocean are used for validation. It is shown that the methods of model bias correction can significantly reduce model errors, but the methods of noise simulation have various performances for different regions.

2B06.4 ID:3545 11:15

Improved surface fluxes for a coupled ocean-atmosphere model

Sergey Skachko [1], *Pierre Gauthier* [1], *Monique Tanguay* [2], *Jean-Marc Bélanger* [2], *Lubos Spacek* [2]
[1] Université du Québec à Montréal (UQAM)
[2] Meteorological Research Division, Environment Canada, Dorval (Québec)
Contact: skachko.sergey@uqam.ca

The objective of this work is to examine the impact of coupling the ocean to an atmospheric model on the quality of forecasts from the short to seasonal and interannual timescales. The application of data assimilation methods to a coupled system may be beneficial with respect to two aspects. First, data assimilation is driven by short-term forecasts from the coupled model and maintains the system trajectory close to the observations by modifying the model state according to the statistical estimation principles underlying the assimilation. As the coupled system introduces unknown parameters to represent heat, moisture and momentum surface flux exchanges between the ocean and the atmosphere, the assimilation can also use observations to estimate unknown parameters used to model these fluxes. This can be useful to improve the processes of ocean-atmosphere interaction and to reduce biases in the coupled model. A coupled ocean-atmosphere data assimilation system is currently being developed within the GOAPP research network. The atmospheric component is the 4D-Var assimilation scheme driven by the GEM model, used operationally by Environment Canada. This is coupled to the global NEMO model. As a first step to building this system, the atmospheric 4D-Var data assimilation component is forced by ocean SST. A parameter estimation scheme is added to the 4D-Var by augmenting the state vector of the atmosphere with model parameters used in the parameterization of heat and momentum fluxes. In this presentation, the results will be discussed regarding the ability of the assimilation system to retrieve correctly the selected parameters from the available observations. The result show that the parameter estiamtion technique improves the forecast quality of the atmosphere model. The estimated parameters will be then used in a fully coupled ocean-atmosphere system to replace traditional bulk formulation of the surface fluxes.

2B06.5 ID:3490 **11:30**

An Exploratory Study into the Joint Assimilation of Atmosphere and Ocean Data

Faez Bakalian [1], *Ritchie Harold* [2], *Thompson Keith* [1]
[1] Oceanography Department, Dalhousie University, Halifax, Nova Scotia
[2] Meteorological Research Division, Environment Canada, Dartmouth, NS, Canada
Contact: bakalian@phys.ocean.dal.ca

An idealized linear state space model of the coupled atmosphere-ocean system, and the Kalman Filter, are used to examine the advantages and disadvantages of independent versus joint assimilation. In independent assimilation, data are assimilated into each of the media and the information is communicated between the media only through the coupling terms. In joint assimilation, the data are assimilated into each of the media but the information is immediately transferred to the other medium through the Kalman Filter; both media are updated simultaneously at each assimilation stage. Significant improvements in forecast skill were observed when joint assimilation was carried out. The implications of this research for the design of assimilation strategies for use in coupled atmosphere-ocean numerical models is discussed.

2B06.6 ID:3941 **11:45**

Refinement of Green's function method for parameter tuning

Tsuyoshi Wakamatsu , *Michael Foreman*
School of Earth and Ocean Sciences, University of Victoria / Institute of Ocean Sciences, DFO

Contact: tsuyoshi.wakamatsu@dfo-mpo.gc.ca

The Green's function method proposed by Menemenlis et al. (2005) has been applied to the NEMO ocean model in order to tune model parameters against data. We have conducted parameter tuning experiments using model-simulated data from the NEMO GYRE configuration and found that the estimated parameters are highly sensitive to the size of the increment used for constructing the data kernel matrix. In order to solve this problem, we have derived an alternative formula for the Green's function method which is less sensitive to the size of the increment.

Operational Oceanography: observations, modelling and data assimilation (Part 1) / Océanographie opérationnelle : observations, modélisation et assimilation des données (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Denis Gilbert), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B07.1 ID:4004 INVITED/INVITÉ 10:30

The MyOcean Project: Working towards a pan-European capacity for Ocean Monitoring and Forecasting

Pierre Bahurel , *Marie Drevillon*
MERCATOR-OCEAN
Contact: mdrevillon@mercator-ocean.fr

MyOcean is the implementation project of the GMES Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting. During years 2009-2011, thanks to EU-FP7 co-fundings, MyOcean will lead the setting up of this new European service, grown on past investments in research & development, system development and international collaborations. The MyOcean Service provides the best information available on the Ocean for the large scale (worldwide coverage) and regional scales (European seas), based on the combination of space and in situ observations, and their assimilation into 3D simulation models: temperature, salinity, currents, ice extent, sea level, primary ecosystems, … The MyOcean service is available: • anywhere (the service covers the whole globe) • at any depth (models give access to a 3D depiction) • at anytime (in real time, with short term forecast, and also past situations for at least the last 25 years) • to anyone (access to products is open and free). Maritime security, oil spill prevention, marine resources management, climate change, seasonal forecasting, coastal activities, ice sheet surveys, water quality and pollution … are some of the targeted applications. This presentation will provide an overview of the MyOcean project objectives and details of the monitoring and forecasting systems and their applications.

2B07.2 ID:3718 11:00

Evaluation of the CONCEPTS Global Ocean Forecasting System

Gregory Smith[1], *Francois Roy*[2], *Jean-Marc Belanger*[1], *Yimin Liu*[3], *Bruce Brasnett*[2], *Fraser Davidson*[3], *Harold Ritchie*[1], *Pierre Pellerin*[1], *Benoit Tranchant*[4]
[1] Recherche en Prévision Numérique, Environment Canada
[2] Centre Météorologique Canadien, Environment Canada
[3] Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada
[4] Mercator-Ocean
Contact: Gregory.Smith@ec.gc.ca

In collaboration with the French operational ocean forecasting centre Mercator-Océan, a Canadian capacity for operational ocean forecasting is being developed as part of the CONCEPTS (Canadian Operational Network of Coupled Environmental PredicTion Systems) project. The main aim of CONCEPTS is the eventual development of global and regional operational coupled atmosphere-ice-ocean forecasting systems. As a first step towards this goal, the Mercator assimilation system, SAM2, has been used to produce weekly 10-day forecasts using the NEMO 1/4° resolution global ice-ocean model. These forecasts are identical to those produced by Mercator, apart from the use of atmospheric forcing from the Canadian weather forecasting model GEM. An evaluation of these forecasts is presented along with a comparison with the MERCATOR operational forecasts. An additional set of forecasts is also presented, which assimilates the operational sea surface temperature (SST) analyses produced by the Canadian Meteorological Centre, in place of the NCEP-RTG SST analysis used by Mercator.

2B07.3 ID:4016 11:15

The C-NOOFS Ocean Forecasting System: Status, progress and web-visualization.

Fraser Davidson[1], *Gregory Smith*[2], *Andry Ratsimandresy*[1], *Jennifer Wells*[1], *Charlie Bishop*[1], *Yimin Liu*[1], *Charles Hannah*[3], *Zeliang Wang*[3], *Maud Guarracino*[3], *Fred Dupont*[3], *Dan Wright*[3]
[1] Northwest Atlantic Fisheries Centre, DFO
[2] Meteorological Research Division, EC
[3] Bedford Institute of Oceanography, DFO

Contact: davidsonf@dfo-mpo.gc.ca

The Canada Newfoundland Ocean Forecasting system is a DFO-EC-DND pilot project in regional operational oceanography under the CONCEPTS MOU. The objective for C-NOOFS is to develop and run a pre-operational ocean forecast at 1/12th degree resolution for the North West Atlantic. The daily run forecast system is described along with validation with in-situ observed profiles. The data assimilation approach is described. Finally we present the accessibility to the forecast system output with the THREDDS data server and web visualization tools such as GODIVA2.

2B07.4 ID:4010 11:30

Direct Insertion of Sea Ice in C-NOOFS

Jennifer Wells [1], *Gregory Smith* [2], *Andry Ratsimandresy* [1], *Charlie Bishop* [1], *Gilles Garric* [3], *Fraser Davidson* [1], *Charles Hannah* [4]
[1] Northwest Atlantic Fisheries Centre, DFO
[2] Meteorological Research Division, EC
[3] Mercator-Ocean
[4] Bedford Institute of Oceanography, DFO
Contact: davidsonf@dfo-mpo.gc.ca

Currently, the Canada-Newfoundland Operational Ocean Forecasting System (C-NOOFS) relies on weekly Mercator-Ocean (MO) forecast results for ice. Efforts are underway to replace these Mercator ice values with 3DVAR ice analyses from CIS/CMC. It is expected that the inclusion of observational sea ice data will produce an overall improvement in the forecasting abilities of the model. Direct insertion is being performed using both the C-NOOFS 1/4 degree and 1/12 degree model configurations. The effectiveness of the method is being tested using forecasts from the 2009/10 winter season. Results show an overall decrease in error in the model when validated using the C-NOOFS Operational Monitoring Package.

2B07.5 ID:3375 11:45

The Canadian Meteorological Centre's New Global Sea Surface Temperature Analysis

Bruce Brasnett
Canadian Meteorological Centre
Contact: Bruce.Brasnett@ec.gc.ca

A new global sea surface temperature analysis expected to be implemented later in 2010 is described. The analysis includes more satellite data, including retrievals from the AMSR-E microwave sensor, than the current analysis. The analysis grid will be upgraded from the current 0.33 deg lat-long to 0.2 deg. The analysis method continues to be statistical interpolation but the background errors are specified from a climatology of the analysis error computed with

realistic datasets. The new analysis also incorporates ice information from CMC's global ice analysis. The impact that the new data and improved resolution have on analysis error will be shown. The ability of the analysis to accurately represent small scale (spatial and temporal) features will be explored. A comparison with global SST analyses produced elsewhere will be included as time permits.

Interactions Among Biogeochemical Cycles (Part 3) / Interactions entre les cycles biogéochimiques (Partie 3)

Room / Endroit (Capitale), Chair / Président (Carl Mitchell), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B08.1 ID:3406 **10:30**

Declining sulphur deposition and emerging issues regarding decreasing calcium in central Ontario lakes

Shaun Watmough
Trent University
Contact: swatmough@trentu.ca

It is well established that an increase in acid (S) deposition and subsequent leaching results in an increase in base cation export from soils into surface waters, with calcium (Ca) being the predominant base cation. Since the early 1980s, S deposition has decreased by more than 50% in Ontario and this has brought about the expected decrease in Ca leaching. However, in many areas Ca leaching has decreased to an extent greater than would be predicted from declining sulphate leaching alone and this has resulted in a less-than-expected improvement in surface water chemistry and recent concerns that Ca levels in some lakes are approaching or are at levels that are lower than pre-industrial values. This greater than expected decrease is thought to be due to soil acidification, which may be exacerbated by timber harvesting. This study documents changes in Ca levels in lakes and soils in central Ontario and uses steady-state and dynamic modelling techniques to estimate past and future lake and soil Ca concentrations. The potential role of forestry in the calcium cycle is assessed and potential implications for aquatic biota are discussed

2B08.2 ID:3871 **INVITED/INVITÉ 10:45**

Declining acid rain: biogeochemical interactions are delaying ecosystem recovery

Dean Jeffries
Environment Canada
Contact: dean.jeffries@ec.gc.ca

During the last 30 years there has been a 50% reduction in North American sulphur dioxide emissions leading to reduced atmospheric sulphate deposition, particularly in the northeastern part of the continent. This led to simplistic expectations that an immediate and commensurate reduction in ecosystem acidification would occur, and in fact, declining surface water sulphate concentrations have followed a parallel track to deposition reductions, although catchment input-output budgets often do not balance. However, ecosystem recovery, as reflected by increasing water pH or alkalinity concentrations, is only commonplace near large local sources that have subsequently greatly reduced sulphur dioxide emissions, e.g., Sudbury. Most regional waters have responded with declining base cation concentrations, increasing dissolved organic carbon concentrations, or both. Both of these chemical trends have significant ecological implications for aquatic ecosystems. The biogeochemical interactions and other factors that influence the acidification/recovery responses will be discussed using regional water chemistry datasets from temporal monitoring networks in eastern Canada and elsewhere, and results from intensive monitoring and research conducted in the Turkey Lakes Watershed (central Ontario).

2B08.3 ID:3413 11:15

Increasing dissolved organic carbon and decreasing sulphate concentrations in stream water: correlation or causation?

Catherine Eimers [1], *Michael Preston* [2], *Shaun Watmough* [1]
[1] Trent University
[2] University of Toronto
Contact: ceimers@trentu.ca

Increasing dissolved organic carbon concentrations (DOC) in streams in many areas of northeastern North America and western Europe have been attributed to declining sulphate levels and associated changes in pH and/or ionic strength. Significant negative correlations between average DOC and sulphate concentrations have been observed at streams in south-central Ontario, but relationships vary by season and catchments that are dominated by wetlands (high DOC systems) show stronger relationships between DOC and sulphate than upland (low DOC) dominated systems. Here we show through the analysis of (a) long-term (30+ year) historical monitoring data, (b) intensive (daily and event targeted) field measurements, and (c) laboratory manipulations, that correlation does not necessarily mean causation, and that factors including hydrology and temperature may provide a more consistent explanation for increasing DOC, although consideration of wetland influence is key. We show that opposing interpretations result when different sources of data are considered (e.g. experimental vs. monitoring), and annually-averaged concentration data provide the least information on processes, yet are most commonly used to

invoke causation.

2B08.4 ID:3437 11:30

Hydrologic controls on winter carbon, nitrogen and phosphorus export from forested catchments

Nora Casson [1], *Catherine Eimers* [2], *Shaun Watmough* [3]
[1] Trent University, Watershed Ecosystems Graduate Program
[2] Trent University, Department of Geography
[3] Trent University, Department of Environmental and Resources Science
Contact: noracasson@trentu.ca

In Ontario, the winter season is characterized by low biological activity but potentially high hydrological export of nutrients from forests during melt or rain-on-snow events. It is a critical time for investigating patterns of nutrient export and cycling since what happens during the winter heavily influences the conditions of the subsequent spring snow melt, the most important time period of the year in terms of hydrological and chemical export, and a major determinant of interannual variation in water and nutrient budgets. However, adjacent catchments of similar size (15 – 26 ha) with similar geology, forest cover, and atmospheric deposition show major discrepancies in winter carbon, nitrogen and phosphorus export. Much of this variability may be due to topographic characteristics which influence flowpaths of water and chemicals. This study investigates differences in carbon, nitrogen and phosphorus export from three catchments in central Ontario with a range of physiographic characteristics from December 2009 to March 2010. Using a combination of daily stream sampling, fortnightly throughfall and snowpack sampling and continuous soil moisture and soil temperature measurements, we were able to determine the relative contributions of melt water, shallow subsurface flow and groundwater sources to stream flow and chemistry, and thus make inferences about cycling and residence time of nutrients in these catchments. The results of this study will help us understand the role of topography and hydrology in regulating winter stream chemistry. Changes in climate are projected to be especially dramatic during the winter in this region, and therefore a thorough understanding of controls on biogeochemical and hydrologic activity are important to predict the sensitivity of these forests to future climate change.

2B08.5 ID:3591 11:45

Analysis of nitrogen controls on carbon and water exchanges in a conifer forest using CLASS-CTEMN^{+} model

Suo Huang [1], *Altaf Arain* [1], *Fengming Yuan* [2], *Vivek K. Arora* [3], *Jason Brodeur* [1], *Matthias Peichl* [1]
[1] McMaster Centre for Climate Change, McMaster University
[2] Institute of Arctic Biology, University of Alaska Fairbanks
[3] Canadian Centre for Climate Modelling and Analysis (CCCma), Environment Canada
Contact: huangs26@mcmaster.ca

Nitrogen (N) controls on carbon and water exchanges were analyzed in a 70-year old eastern temperate conifer forest at Turkey Point in southern Ontario, Canada from 2003 to 2007 using a newly developed coupled carbon (C) and nitrogen (N) model. CLASS-CTEMN$^+$ includes N cycle controls on the C cycle in the coupled version of the Canadian Land Surface Scheme (CLASS) and the Canadian Terrestrial Ecosystem Model (CTEM). Key soil and plant N cycling algorithms including biological fixation, mineralization, nitrification, denitrification, leaching and N controls on plant photosynthesis capacity were incorporated in CLASS-CTEMN$^+$. Simulated values of soil-plant N contents and C and N fluxes, including the N_2O flux, were compared with available observation-based estimates for the 5-year (2003-2007) period. Comparison of the coupled CLASS and CTEM models with and without C-N coupling revealed N controls on photosynthetic uptake and water loss. Predictions of daily gross ecosystem productivity (GEP), ecosystem respiration (Re), net ecosystem productivity (NEP) and evapotranspiration (ET) showed better agreement with eddy covariance (EC) flux measurements when C-N coupling is included. Annual simulated values NEP also compared better with observation-based estimates when C-N coupling is included. Annual NEP values were 134, 195, 183, 225 and 255 g C m^2 yr^{-1} for the 2003-2007 period when C-N coupling is included compared to 535, 562, 507, 540, and 535 g C m^2 yr^{-1} when N controls on the C cycle are switched off, for respective years. Observation-based NEP values were 220±67, 126±67, 33±67, 142±67 and 102±67 g C m^2 yr^{-1} for the 2003-2007 period. Overall, the impacts of N limitations on carbon fluxes were more pronounced during early spring, late autumn and winter seasons. When implemented in earth system models, terrestrial ecosystem models with N cycle constraints on photosynthesis will help evaluate the response of the terrestrial biosphere to feedbacks associated with the N cycle.

Weather and Society - Integrated Studies (Part 1) / La météo et la société - Études intégrées (Partie 1)

Room / Endroit (Panorama), Chair / Président (Rebecca Wagner), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B09.1 ID:3572 **INVITED/INVITÉ 10:30**

La vigilance météorologique

Catherine Boretti
Météo-France

Contact: jacques.descurieux@ec.gc.ca

Suite aux tempêtes de décembre 1999, le Ministère de l’Intérieur, Météo-France et le Ministère du Développement durable ont décidé de mettre en œuvre un dispositif agencé autour d’un langage commun : une échelle de quatre couleurs correspondant à des niveaux de risque, selon un découpage territorial unique, le département, adapté aux structures de planification et de gestion des crises, une échéance de 24 heures conjuguant une fiabilité correcte des prévisions et une anticipation suffisante pour l’action.

Ce langage commun et simple permet au service météorologique français de diffuser très largement ses prévisions de « risque potentiel » liées aux critères météorologiques sous forme de « carte de vigilance ». L’information est diffusée simultanément aux services en charge de la sécurité civile, aux opérateurs nationaux, aux média et au grand public. Même s’il s’agit au départ d’une prévision météorologique, ce signal clair et unique déclenche une posture préventive qui s’accompagne selon les besoins de bulletins, de briefings personnalisés et d’imageries pour que chaque décideur adapte sa réponse. Le grand public, étant largement informé du risque et des comportements préconisés, se retrouve lui aussi acteur de sa sécurité.

Ce dispositif, évalué par les partenaires, évolue au fil des années. Ces évolutions traduisent la volonté d’amélioration de ce système, qui a su faire preuve de son efficacité dans la politique de réduction des risques de catastrophes naturelles en France, et se faire connaître des Français : en 2009, la notoriété de Vigilance atteignait 86 % d’après une enquête auprès de 2000 personnes.

2B09.2 ID:3603 11:00

Weather Vigilance Project : Prototype Results

Olivier Gagnon
Environnement Canada
Contact: olivier.gagnon@ec.gc.ca

In 2009, the Meteorological Service of Canada has launched a regional pilot project to increase the relevance and reach of its hazardous weather warnings. The weather vigilance project aims at linking the weather forecasts with their foreseeable impacts.

This presentation will present the results of trial run of this new approach and compare it with Environment Canada’s regular warning procedure. An emphasis will be put on the risk perception based communication and operational dialogue with stakeholder.

2B09.3 ID:3500 11:15

Meteorological Event Lessons Learned Analysis (MELLA): a Tool for the

Warning Preparedness Program of the Meteorological Service of Canada. - L'Analyse des leçons météorologiques apprises (ALMA): un outil pour le Programme des météorologistes en sensibilisation aux alertes du Service météorologique du Canada.

Denis Gosselin
Environnement Canada
Contact: Denis.Gosselin@ec.gc.ca

A MELLA (Meteorological Event Lessons Learned Analysis) is a tool to capture and evaluate the chain linking the events, the activities, the intended outcomes and what really happened. A MELLA is factual and evidence based. It relies on the analysis of evidentiary material normally used in qualitative analyses. That tool has recently been implemented as a component of the Warning Preparedness Meteorologist (WPM) Program of the Meteorological Service of Canada (MSC). A few pilots were realized over the last few years under collaborative efforts between the Kelowna National Services Office and regional components of the WPM Program. Workshops on the tool as well as on related topics were provided to Warning Preparedness Meteorologists over the same period. Support documentation was developed on the basis of proposals from the Kelowna NSO and office of the ADM for the MSC. The use of MELLA will provide much needed information in key areas. The lessons learned aspect will be the basis for quality assessment and program improvements in identifying gaps and successes. Documented relationships between meteorological conditions and associated impacts will contribute to existing work in that area as well as to the development of other tools such as Vigilance Map.

Une ALMA (analyse de leçons météorologiques apprises) est un outil permettant de saisir et d'évaluer le fil des événements, des activités, des résultats anticipés et de ce qui est véritablement arrivé. Une ALMA est factuelle et basée sur des évidences. Elle se fonde sur l'analyse de matériel normalement reconnu comme évidences dans les analyses qualitatives. Cet outil a récemment été implanté au sein du Programme des météorologistes en sensibilisation aux alertes (MSA) du Service météorologique du Canada (SMC). Suite à des efforts de collaboration entre le Bureau national de services de Kelowna et des composantes régionales du Programme des MSA, quelques analyses expérimentales ont été réalisées au cours des dernières années. Des ateliers sur cet outil d'analyse ainsi que sur des sujets connexes ont également été fournis aux météorologistes en sensibilisation aux alertes au cours de la même période. La documentation de support a été développée à partir de propositions en provenance du BSN de Kelowna et du bureau du SMA pour le SMC. L'utilisation de l'ALMA fournira des informations très en demande dans des domaines critiques. L'aspect relatif aux leçons apprises servira de base à l'évaluation de la qualité et à l'amélioration du programme en permettant l'identification des lacunes et des succès. Les relations documentées entre les conditions météorologiques et les impacts qui leur sont associés seront mis à contribution dans divers travaux menés dans ce domaine ainsi que pour le développement d'autres outils comme la Carte de vigilance.

2B09.4 ID:3973 11:30

Météorologistes intégrés au sein de la sécurité civile au Québec

Claude Masse
Environnement Canada
Contact: claude.masse@ec.gc.ca

Durant l'automne 2007, il y a eu des évènements qui ont fait ressortir des lacunes au niveau de la communication de l'information météorologique afin d'optimiser les prises de décision avec les organismes d'interventions d'urgences sur le terrain.

Alors de commun accord avec les responsables de la sécurité civile du Québec, les météorologistes d'Environnement Canada seraient intégrés à l'équipe de la sécurité civile. Lors d'urgences résultant de situations météorologiques dangereuses les météorologues intégrés dans les bureaux de la sécurité civile contribuent au processus décisionnel et par conséquent une valeur ajoutée aux informations météorologiques. Le facteur humain est souvent sous estimé dans le processus de décisions en croyant que les humains vont prendre des optimales en situations d'incertitudes. Cette présentation les résultats obtenus par l'échangeant non seulement d'informations objectives et de connaissances multidisciplinaires entre les météorologistes, les hydrologues, les ingénieurs de mécanique du sol et autres selon les situations d'urgences.

2B09.5 ID:4042 11:45

What makes weather important: Making meteorology more user-friendly for Canadians.

Lisa Vitols [1], *Jennifer Spinney* [2]
[1] Environment Canada
[2] University of Western Ontario
Contact: lisa.vitols@ec.gc.ca

Each day Environment Canada attempts to ensure the development and dissemination of equitable weather forecasts for the Canadian public. Believing inherently in the usefulness of these forecasts, the meteorological community strives to fulfill this mandate so that citizens are better equipped to make effective decisions to protect themselves and their property. If the meteorological community wishes to affect these decisions, then it is imperative to understand if and how the Canadian public uses, values, and interprets the weather information provided to them. Therefore, we seek to illustrate the importance of integrating local perspectives into the development of Canadian meteorological products and services. Specifically we hope to illuminate the multiple ways in which to carry out an integrated approach (marrying user needs with appropriate weather information options) from the point of conception through to delivery. We will highlight the networks and partnerships currently being fostered, lessons learned, the role of culture and geography in people's need for and access to weather information, and the value of effective education and communication around meteorological information. Overall we hope to emphasize that the future of meteorological services to Canadians will necessitate working closely with Canadians.

General Hydrology Session (Part 1) / Séance générale sur l'hydrologie (Partie 1)

Room / Endroit (Pinnacle), Chair / Président (Sean Carey), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B10.1 ID:3407 **10:30**

Quantifying trends in ecohydrological variables for regime-based groups of Canadian rivers

Wendy Monk [1], *Daniel Peters* [2], *Donald Baird* [3], *Allen Curry* [1]
[1] Canadian Rivers Institute, University of New Brunswick
[2] Environment Canada - Water - Climate Impacts Research Centre
[3] Environment Canada - Canadian Rivers Institute
Contact: wmonk@unb.ca

The high degree of spatial and temporal variability in hydrological regimes across North America reflects a wide-ranging climatic and landscape controls on streamflow generation. Long-term (1970-2005) daily data were extracted for a subset of natural hydrological gauging stations following assessment for data quality from Canada's Reference Hydrological Basin Network. Based on long-term standardized weekly averages, an agglomerative hierarchical classification method was applied to identify homogenous regions with similar seasonality of the flow regime. Exploratory magnitude analysis indicated that classification based upon the non-standardized discharge time-series was strongly biased by catchment area. Thus, weekly averages of daily discharge records (m^3 s^{-1}) were expressed as runoff (mm $week^{-1}$) to standardize for differences in catchment area, and the classification methodology was reapplied. Reflecting the climatic and geographical variability across Canada, six regime regions were identified reflecting the timing of the annual peaks and low flows in addition to the patterns in the rising and falling limbs. For each of the gauging stations, the magnitude, duration, timing, frequency and rate of change of annual hydrological events were quantified through 32 ecologically-important hydrological variables. Long-term patterns (1970-2005) in the ecohydrological variables were quantified using the non-parametric Mann-Kendall trend statistic. A series of GIS maps were produced to explore the spatial distribution of these clusters and to help in the

explanation of the patterns. Results at the national scale were highly variable although there appeared to be significant trend towards increased variability in river flows. Clear regional patterns were observed within individual regime groups, for example rivers with a clear Maritime flow regime have demonstrated a significant decrease in the annual minimum runoff. The approach of identifying river regions could allow the future development of tailored management strategies.

2B10.2 ID:3936 **10:45**

Watershed-Scale Trend and Variability Assessment of Ecologically Relevant Streamflow Variables for the Athabasca River: Implications for Development

Daniel Peters [1], *Wendy Monk* [2], *Donald Baird* [3]
[1] Environment Canada @ Water & Climate Impacts Research Centre, University of Victoria, Victoria, BC
[2] Canadian Rivers Institute, University of New Brunswick, Fredericton, NB
[3] Environment Canada @ Canadian Rivers Institute, University of New Brunswick, Fredericton, NB
Contact: daniel.peters@ec.gc.ca

The Athabasca River in northwestern Canada, the dominant inflow to Lake Athabasca and Peace-Athabasca Delta complex, continues to be influenced by multiple environmental stressors on its hydrology and aquatic ecology, including land-use change, climate variability/change, industry and municipal water uses. An emerging issue regarding the hydrology and aquatic ecology of this internationally recognized complex is the upstream abstraction of water for the processing of oil-sands deposits located in the lower Athabasca River region of northern Alberta. The Department of Fisheries and Oceans (DFO) in collaboration with Alberta Environment have developed an instream flow needs (IFN) framework for the lower Athabasca River. Historical winter flow conditions have occurred and will very likely re-occur that would put the river in “red zone” of the proposed IFN, even in the absence of water withdrawals. Furthermore, a number of hydrological issues are not explicitly considered in the IFN recommendations, such as watershed scale water availability and sustainability of ecological flow in a varying and changing climate. The goal of this study, the first in a series tackling these hydrological issues, is to perform a historical flow assessment at the watershed scale. Specifically, historical trends and variability will be examined for 33 ecologically important indicators of hydrological alteration (e.g., magnitude and timing of peak and low flows, rate of rise and fall, and number of flow reversals) for all available tributary and mainstem hydrometric stations, some of which date back to the early 1900’s. This study will enhance our understanding of streamflow behaviour at the watershed-scale and possible implications for additional development.

2B10.3 ID:4014 **11:00**

The river ice break-up season in Canada: variations in water levels and timing

Simon Von De Wall [1], *Terry Prowse* [2], *Laurent De Rham* [2]
[1] University of Victoria, Water and Climate Impacts Research Centre
[2] Water and Climate Impacts Research Centre
Contact: swall@uvic.ca

The annual break-up of river ice is a significant component of the spring freshet on rivers in the Northern Hemisphere and has been identified as a dominant control of annual peak water levels. Notwithstanding the environmental implications, the direct physical action of river ice and associated flooding during break-up can cause extensive damage to hydroelectric and transportation infrastructure and incur substantial financial costs. In addition, a number of studies have expressed concern over the economic and environmental significance of the river ice break-up season as effects are expected to be exacerbated in the future. Presented here is a Canada-wide analysis of the trend (Mann-Kendall) in break-up water levels as well as quantitative timing related variables representative of the river ice break-up season. The data was extracted from original pen chart records of 136 Water Survey of Canada hydrometric stations and maximized for the 1969-2006 period. In general, trends in water levels observed at the initiation of break-up (HB), as well as maximum water levels at break-up (HM) show declines ranging from 0.1-0.5 m/decade and 0.1-1.2 m/decade respectively. Simultaneously, the timing of both events has advanced by 1.4-4.7 days/decade for the former and 1.2-5.6 days/decade for the latter. Similarly, the timing of 'last B date' (last day of ice effects) has advanced by 1.5-8.6 days/decade. Assessed also are river ice break-up phases including break-up drive (t1), wash (t2) and duration (t3). With the exception of a few sites, the time (days) elapsed between break-up initiation and occurrence of peak water level (t1), shows no trend. In contrast, the majority of sites show an increase in the time elapsed between peak water level occurrence and 'last B date' (break-up wash, t2). Similar results are observed for the break-up duration (t3), suggesting that river ice break-up is occurring over a longer period of time. In addition to an overall reduction in break-up water levels and a prolonged break-up season, the results of this work confirm previous findings of an earlier occurrence of river ice break-up.

2B10.4 ID:4025 **11:15**

The impact of permafrost disturbances and sediment loading on the seasonal mixing of two High Arctic lakes

Hilary Dugan , *Scott Lamoureux* , *Melissa Lafrenière* , *Ted Lewis*
Queen's University
Contact: hilarydugan@gmail.com

West and East lakes, Cape Bounty, Melville Island, Nunavut (74'N, 109'W) were studied over the melt seasons of 2003-2009. The lakes are morphometrically similar, with maximum depths of 30-34 m, and surface areas of 1.4-1.6 km2.

Prior to the onset of nival melt, the lakes are isothermal, with slightly elevated conductivity, turbidity and low dissolved oxygen in a shallow layer in the lower 1-2 m. At the onset of melt, underflows generated from river inflow typically deliver fresh oxygenated water to the bottom of the lake and replace the lower water. By mid-June, both lakes have fully mixed, and temperature, conductivity, turbidity and oxygen are typically uniform throughout the water column. This seasonal mixing, observed in most Arctic freshwater lakes, is critical for benthic ecosystems in these environments.

In 2007, record July air temperatures led to significant active layer thawing and subsequent active layer detachments in the West watershed. The disturbances immediately increased the sediment load in the river and overall sediment availability in the watershed. By comparison, disturbances in the East catchment were minimal. By the spring of 2009, the mid-column and bottom water turbidity of West Lake had increased to 15 and 400 NTU, respectively. Elevated levels of total organic carbon and total nitrogen were concomitant with the high turbidity. The elevated turbidity generated a density barrier in the hypolimnion, and unlike previous years, river inflow did not flush bottom water and replenish dissolved oxygen during the melt season. These results provide insights into the downstream impact of permafrost disturbance in a coupled river-lake system. In particular, the post-2007 sediment loading changed the lake from a seasonally mixed environment to one that is amictic and highly turbid.

2B10.5 ID:3494 11:30

Bringing science into river systems cumulative effects assessment practice: A conceptual framework

Nicole Seitz [1], *Cherie Westbrook* [1], *Bram Noble* [2]
[1] Department of Geography, Centre for Hydrology, University of Saskatchewan
[2] Department of Geography, School for Environment and Sustainability, University of Saskatchewan
Contact: nicole.seitz@usask.ca

Increased land use intensity has influenced river systems in Canada. Land uses such as agriculture, forestry, urban growth and industrial development produce incremental and accumulating effects that interact over space and time and adversely affect river water quality and quantity. Cumulative environmental effects are defined as the results of actions that are individually minor but collectively significant when added to other past, present, and reasonably foreseeable future actions. Cumulative effects assessment (CEA) is the process of evaluating the impact a development project (i.e. a coal mine) may have on the ecological surroundings and is a requirement under the Canadian Environmental Assessment Act. However, current approaches to river systems cumulative effects assessment are ineffective, which is largely attributed to the disconnect between the science and practice. This gap is highlighted by the disagreement in the CEA literature, poor use of quantitative methods by individuals who conduct CEA, and spatiotemporal scale issues. There is a need for improved cumulative effects assessment for river systems. In response to this need, we have developed a conceptual framework for better integrating science and practice for improved CEA. The framework achieves this with a review of the CEA literature that highlights the differing views and identifies key quantitative methods that should be included in CEA. Furthermore, the current state of CEA science and CEA practice is identified, key issues and challenges inherent to both components are explained, and the types of science needed to move the practice forward are proposed. The intended outcome is to provide project proponents and land managers with a scientifically sound framework for cumulative effects assessment of river systems.

2B10.6 ID:3311 **11:45**

Assessing “Fitness for Purpose” for Environmental Data

Paul Whitfield
Meteorlogical Service of Canada
Contact: paul.whitfield@ec.gc.ca

While fitness for purpose is the principle universally accepted among scientists as the correct approach to obtaining data of appropriate quality, many scientists or end-users of data are not in a position to specify exactly what quality of data is required for a specific task. Collectors of environmental observations provide data "as is” offering no guarantee or warranty concerning the accuracy of information contained in the data, in particular, no warranty either expressed or implied is made regarding the condition of the “product” or its fitness for any particular purpose. While the increasing implementation of ISO 9002 will benefit users in the future, the reality is that many of the existing data bases generally contain data that was not gathered with present standards and protocols. While it is important that hydrometric and climate services and networks focus on capturing data that are fit for their intended purpose; the burden for assessing the actual fitness for use lies entirely with the user. Some principles and tools for assessing fitness for purpose will be discussed using examples from Canadian climate stations.

Aviation Meteorology / Météorologie aéronautique

Room / Endroit (Bytowne), Chair / Président (Stewart Cober), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B11.1 ID:4073 **10:30**

Recent Improvements and Evaluations of the Canadian Airport Nowcasting System (CAN-Now)

George Isaac [1], *Monika Bailey* [1], *Faisal Boudala* [1], *Stewart Cober* [1], *Robert Crawford* [1], *Norman Donaldson* [1], *Marc Fournier* [2], *Ismail Gultepe* [1], *Laura Huang* [1], *Alister Ling* [3], *Janti Reid* [1]
(Presented by *G.a. Isaac*)
[1] Cloud Physics and Severe Weather Research Section, Environment Canada
[2] CMAC-East, Environment Canada
[3] CMAC-west, Environment Canada
Contact: george.isaac@ec.gc.ca

The Canadian Airport Nowcasting Project (CAN-Now) has developed an advanced prototype all-season weather forecasting and nowcasting system that can be used at major airports. This system uses numerical model data, pilot reports, ground sensor observations (precipitation, ceiling, visibility, winds, etc) as well as remote sensing (satellite, radar, radiometer) information to provide detailed nowcasts out to approximately 6 hours. The nowcasts, or short term weather forecasts, should allow decision makers at airports such as pilots, dispatchers, de-icing crews, ground personnel or air traffic controllers to make plans with increased margins of safety and improved efficiency. The system is being developed and tested at Toronto Pearson International Airport (CYYZ) and Vancouver International Airport (CYVR) with some plans for other HUBs such as Calgary and Montreal. A Situation Chart has being developed to allow users to have a high glance value product which identifies significant weather related problems at the airport. Some new products which mathematically combine observations and numerical model output into Nowcasts are being tested. This talk will describe recent developments, some evaluations, comments from users, and plans for the future.

2B11.2 ID:3492 11:00

The NAV CANADA Automated Weather Observation System

Faycel Farza
NAV CANADA
Contact: farzaf@navcanada.ca

NAV CANADA is replacing the legacy network of Automated Weather Observation Systems (AWOS) with a new generation of AWOS that is compliant to the Transport Canada exemption to Canadian Aviation Regulations 804.01 (c). Starting with a commercial-off-the-shelf system, which was evaluated for one year with a co-located human observer at Iqaluit Nunavut and St John’s Newfoundland and Labrador, the NAV CANADA AWOS is the result of an extensive effort for algorithm enhancements, implementation of quality assurance processing, and iterative data analysis and testing. In addition to the weather parameters measured by the legacy AWOS it replaces, the NAV CANADA AWOS reports runway visual range, lightning data and density altitude. The NAV CANADA AWOS also features an exclusive remote access capability to monitor

the system health and to remotely suppress sensor data. It also interfaces to proprietary systems such as 24/7 monitoring system at Area Control Centres, Air Traffic Control weather display systems, manned weather observation entry systems and radio weather broadcast systems. The NAV CANADA AWOS reports weather data in BUFR format, based on the world meteorological organization standards, as well as in a comprehensive text stream. It is the only CAR compliant AWOS that generates official aviation routine and special weather observations (METAR/SPECI) from which Environment Canada can produce regulatory compliant aerodrome forecasts (TAF).

2B11.3 ID:3434 11:15

Conditional persistence application to ceiling and visibility nowcasting

Bjarne Hansen , *Alister Ling* , *Ismail Gultepe*
Environment Canada
Contact: bjarne.hansen@ec.gc.ca

In general, the method of basic persistence (BP) is difficult to outperform in nowcasting (0-to-6 h) cloud ceiling and horizontal visibility at airports, particularly for the first few hours. BP is a simple forecast method in which current conditions are held constant. To produce forecasts for airports (TAFs), it is common practice for aviation meteorologists to forecast that current categories of ceiling and visibility will persist for the first few hours, except in cases where imminent changes are expected in related variables and causative factors (e.g., a frontal passage, onset or cessation of precipitation, diurnal heating). Previous studies have shown that routine application of BP for nowcasting achieves relatively high skill compared to standard methods of verification (e.g., POD, FAR, CSI). In this study, BP is compared with conditional persistence (CP), which combines the fundamental forecast methods of persistence and conditional climatology. This CP methodology matches current conditions with historical observations, then uses the evolution of those cases in the following hours as the basis for the current forecast. Verification results suggested that a retrospective comparison of forecast skill of CP with BP shows CP outperforms BP. An example of a recurring, specific type of weather regime in which CP forecasts relatively well is discussed. A possible routine application of CP as a tool to assist in operational forecasting is discussed.

2B11.4 ID:3623 11:30

Updated results for regime-based persistence probability of ceiling and visibility

Alister Ling , *Bjarne Hansen* , *Ismail Gultepe*
Environment Canada
Contact: Alister.Ling@ec.gc.ca

Several ceiling and visibility (C&V) objective forecast guidance systems use persistence as one input among several methods, in addition to using it as a benchmark for verification. For best results, these systems need to determine when persistence has a high probability of failure and adjust the crossover time to other methods appropriately. This paper presents additional results for regime-based performance of persistence, demonstrating that in certain conditions a change of category is likely. Also, it is proposed that nowcasting systems should not use persistence as a forecast methodology. Generally, persistence is assgined a relative weight that decreases with projection time, based on recent past performance (which may be inappropriate) or on a regression approach (its use of bulk statistics obscures less common high impact events). This work is done in conjunction with Hansen et al.'s studies on climatology and conditional persistence.

2B11.5 ID:4080 11:45

Nowcasting of Runway Visual Range, Visibility and Wind Gust at Pearson International Airport

Faisal Boudala , *George Isaac* , *Stewart Cober* , *Ismail Gultepe* , *Janti Reid* , *Laura Huang* , *Robert Crawford* , *Ivan Heckman*
Environment Canada
Contact:

Weather conditions that are associated with winter snow storms affect daily human activities, including air and ground transportation, by reducing visibility (lv) or Runway Visual Range (RVR) for aircraft pilots, and causing other severe weather phenomena such as blowing snow associated with strong wind and heavy snow precipitation (S). Thus, observation and short term prediction of these quantities are very important for aviation, airport ground operation, and public transportation. Many of the current Numerical Weather Prediction (NWP) models are not capable of explicitly predicting these parameters and thus have to be diagnosed based on some kind of parameterization. The current Transport Canada hold-over time guidelines for aircraft ground-icing operations utilize snowfall intensities which are also based on visibility. Recently Boudala and Isaac (2009) have noted the importance of temperature and developed algorithms for lv as a function of temperature and snowfall rate, and other relevant meteorological parameters using both in-situ aircraft and surface observation data. In the same paper, the probability density function (PDF) for visibility was also developed. These algorithms have been tested using measurements at Toronto Pearson International Airport during winters of 2007, 2008 and 2009 as part of Canadian Airport Nowcasting Project (CAN-Now). In this talk, the development, testing, and application of these algorithms for nowcasting lv, RVR, wind gust using the Canadian GEM Regional (GEM-REG) and Limited Area (GEM-LAM) models will also be presented.

Insights into seismic hazard / Risques sismiques

Room / Endroit (York), Chair / Président (Robert Shcherbakov), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B12.1 ID:3577 10:30

Comparisons of ground-motion processes in eastern North America versus California, and implications for seismic hazards

Gail Atkinson , *Karen Assatourians*
University of Western Ontario
Contact: gmatkinson@aol.com

A key input for seismic hazard analysis is the set of relationships that predict ground-shaking amplitudes as a function of earthquake magnitude and distance. A critical question for such relationships concerns the extent to which source and attenuation characteristics differ between sparsely-instrumented eastern North America (ENA) and data-rich California. We use amplitude comparisons for moderate events (M3 to 5.5) to examine and contrast the attenuation characteristics of ground motions in California with those in ENA. The comparisons are facilitated by use of the recently-compiled ShakeMap database of Chiou and Youngs for California (2010 Earthquake Spectra) and by the ENA ground-motion database of the Engineering Seismology Toolbox (www.seismotoolbox.ca). Within 70 km of the earthquake source, ground motions in California in the frequency range from 1 to 3.3 Hz appear to have similar attenuation characteristics to those in ENA. Eastern motions become significantly slower in their attenuation (relative to California) at larger distances, and typically show more pronounced ‘Moho bounce’ effects. Point-source stochastic simulations are used to infer and compare basic source excitation parameters across the regions. The seismic hazard implications of the findings are discussed.

2B12.2 ID:4049 10:45

Focal mechanism of earthquakes in western Quebec and tectonic stress

Parisa Asgharzadeh , *Savka Dineva*
Queen's University
Contact: sdineva@geol.queensu.ca

The main objective of this study is to obtain information about the focal mechanism for subsequent characterization of the present-day regional tectonic field in western Quebec. It also attempts to differentiate local zones with comparatively homogeneous tectonic stress and seismic regime, thus providing information for future re-assessment of the seismic hazard in each region. The

study concentrates on determination of the focal mechanisms of 60 earthquakes with magnitude > 3.5 after 1992. The arrival times and polarities of P-waves are analysed. Hypocenter locations and earthquake focal mechanisms of earthquakes with their accuracy are calculated. A stress inversion is carried out for different scale areas to establish the present-day regional tectonic stresses and some local variations.

2B12.3 ID:3673 11:00

Paleoliquefaction study in Charlevoix seismic zone and St. Lawrence Lowlands: Implications for seismic zazards

Martitia Tuttle [1], *Gail Atkinson* [2]
[1] M. Tuttle & Associates
[2] University of Western Ontario
Contact: mptuttle@earthlink.net

The Charlevoix seismic zone (CSZ) has been the source of repeated large earthquakes during the past 10,000 years, while the adjacent Quebec City- Trois Rivieres area (QCTR) has not. This was determined from systematic searches for earthquake-induced liquefaction features in Holocene and Late Wisconsin deposits exposed in river cutbanks in both areas, radiocarbon dating of deposits where liquefaction features were found and not found, and liquefaction potential analysis to evaluate scenario earthquakes in the CSZ and the magnitude threshold of liquefaction in the QCTR. At least three generations of liquefaction features, including features that formed about 5,000 and 10,000 years ago, were found in the CSZ. By contrast, no evidence of liquefaction was found in the QCTR despite searching a much larger area and twice as much river length. Liquefaction analysis suggests that the Charlevoix earthquakes were of moment magnitude, M, ≥ 6.2 and that large Charlevoix earthquakes are not likely to induce liquefaction in the QCTR, whereas local earthquakes of M 5.5-6.3 would be likely to do so. The apparent absence of liquefaction features in the QCTR suggests that few, if any, large earthquakes have occurred there during the past 10,000 years. We conclude that the rate of large earthquakes has been much higher in the CSZ than in the QCTR for thousands of years. Thus, the presence of Iapetan rift faults, in itself, may not be indicative of the potential for large earthquakes. This finding has important implications for hazard assessment on other Iapetan rift faults in southeastern Canada and the eastern United States, and for seismic source zone characterization across eastern North America. An alternative possibility is that seismicity may migrate along Iapetan rift faults over periods longer than 10,000 years. Additional studies along the St. Lawrence valley should help to resolve these issues.

2B12.4 ID:3392 11:15

Do supershear rupture velocities affect aftershock statistics? A case study: The 2002 Mw 7.9 Denali Earthquake aftershock sequence

Pathikrit Bhattacharya , *Robert Shcherbakov*

University of Western Ontario
Contact: pbhatta4@uwo.ca

Though supershear ruptures were theoretically predicted more than 30 years ago and first reported about 25 years ago (for the 1979 Imperial Valley event), the fact that supershear ruptures are not very rare has become clear only recently. Supershear ruptures produce a seismic shock wave similar to the sonic boom produced by a supersonic airplane and this, possibly, increases the destructive potential of the seismic event. It has been recently reported that the aftershocks of such supershear earthquakes are distributed away from the main fault due to off fault stress redistribution produced by this supershear boom. We study the scaling properties of the aftershock sequence of a supershear earthquake, the 2002 Mw~7.9 Denali event, to look at the effect of the supershear rupture speed on the established empirical scaling properties of aftershock sequences. We observe that the sequence exhibits non-trivial scaling behavior in magnitude, aftershock decay rate and aftershock interoccurrence times. In particular we observe a marked variability in the Gutenberg-Richter exponent, the b value, in space, time and over different magnitude ranges. We find strong indications that certain aspects of this variability might be ascribed to the occurrence of some of the aftershocks on and around the supershear rupture associated with the event. We further outline a method to obtain an average b value, consistent with the theory and statistical properties of the data, for sequences exhibiting such variability in the Gutenberg-Richter exponent. We also examine the validity of the Bath's Law and find an unusually large difference between the magnitude of the largest aftershock and the mainshock. The aftershock rate decays according to the modified Omori Law. The interoccurrence times distributions for different magnitude cut-off's collapse into a single curve following a Gamma function scaling and the distributions can, in general, be described using the concept of non-homogeneous Poisson processes.

2B12.5 ID:4047 11:30

Scaling of earthquake spectra in southern Ontario/western Quebec

Savka Dineva [1], *Robert Mereu* [2], *Gail M. Atkinson* [2]
[1] Queen's University
[2] University of Western Ontario
Contact: sdineva@geol.queensu.ca

We analyse spectra from 366 earthquakes of energy magnitude (ME) 1.1 to 5.4 recorded by the Southern Ontario Seismic Network (SOSN) /POLARIS network during the period 1991-2009 in the area of southern Ontario and western Quebec. Over 3000 S-wave spectra are processed, and used to examine scaling relationships such as the scaling of corner frequency with magnitude, and the relationship between energy and moment magnitude. Several factors that affect observed spectra are considered in this study: the attenuation of seismic waves, the station site response, random scattering effects, the station azimuth, and the magnitude of the earthquakes. Examination of individual attenuation-corrected

spectra reveals a lot of complexity and variation in corner frequency from station to station for the same event, but this can be greatly reduced by stacking the spectra into various bins by event or by magnitude. Some of the bins for a single magnitude contain more than 300 spectra. The corner frequency for the stacked spectra was calculated by fitting to a theoretical Brune (omega-squared) spectra. We obtain a very well-constrained linear relationship between log (corner frequency) and energy magnitude. (The energy magnitude is defined in Dineva and Mereu (2009).) We also obtain relationships between energy magnitude, moment magnitude, and stress drop. The stacking of the spectra into bins is a useful tool to enable overall scaling relationships to be determined with greater confidence.

2B12.6 ID:3977 11:45

Seismicity based earthquake forecasting: Past, present and future

Kristy Tiampo [1], *Caitliin Latimer* [1], *Patricia Perlock* [1], *Nelson Cho* [1], *Christopher Serino* [2], *James Holliday* [3], *John Rundle* [3], *William Klein* [2]
[1] University of Western Ontario
[2] Boston University
[3] University of California at Davis
Contact: ktiampo@uwo.ca

Nearly ten years ago, a new approach to the study of seismicity was introduced (Rundle et al., 2000; Tiampo et al., 2002). The Pattern Informatics (PI) index is a method to objectively quantify the spatiotemporal seismicity rate changes in historic seismicity by normalizing the local changes in seismicity to the long-term background rate for the region, thus systematically pinpointing variations relative to that background rate and identifying localized regions of increased or decreased activity (ie. activation or quiescence). Recognizing that the seismicity rate is proportional to the stress change rate, and thus systematic space-time variations in seismicity occur in response to changes in the underlying stress field (Dieterich, 1994; Tiampo, et al., 2006), the PI methodology therefore indirectly quantifies the underlying stress change in terms of the change in seismicity rate relative to the background seismicity. While patterns in seismicity related to quiescence or activation have, in the past, been interpreted as precursory phenomena (Bowman et al, 1998; Habermann, 1987; Jones and Hauksson, 1997; Mogi, 1969; and many others), their objective quantification had remained elusive. The resulting prospective forecast for the time period 2000 through 2010 (Rundle et al., 2002; Tiampo et al., 2002), inclusive, was the first official such publication in many years. Since that time, the PI method and the resulting forecast have been evaluated, discussed and analyzed at some length. Here we will discuss what has been learned in the intervening time period about the PI technique and seismicity-based forecasting in general, secondary analyses and insights gained from this particular methodology, and the ongoing goals of this research.

Geodesy and Geodynamics / Géodésie et géodynamique

Room / Endroit (Laurentian), Chair / Président (Joseph Henton), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B13.1 ID:4236 INVITED/INVITÉ 10:30

Recent improvements to GNSS products and data access

Pierre Heroux , *Jan Kouba* , *Yves Mireault* , *Paul Collins* , *François Lahaye* , *Pierre Tétreault* , *Mark Caissy* , *Ken Macleod*
Natural Resources Canada
Contact: Pierre.Heroux@NRCan.gc.ca

As the International GNSS Service (IGS) approaches the end of its second decade of support to global geodesy, improvements to Global Navigation Satellite System (GNSS) data access and product accuracy are still being realised. As long-standing collaborator to IGS, Natural Resources Canada's Geodetic Survey Division strives to maintain pace with the evolution of GNSS technology by facilitating access to GNSS data, improving satellite orbit modeling and terrestrial reference frame realisation. These activities are conducted in collaboration with the Earth and atmospheric science communities so that enhanced GNSS capabilities are readily integrated into end-user applications that respond to the needs of Canadians.

This presentation will highlight some recent developments in GNSS data acquisition standards and applications that enable real-time precise positioning in an emerging multi- constellation environment. The benefits of combined GPS/GLONASS solutions will be reported along with a comparative analysis of Precise Point Positioning (PPP) performance with improved atmospheric and Earth-tide models. Progress on the application of a decoupled clock approach to precise positioning using undifferenced phase observations, and the impact it currently has on precise positioning and timing, will also be presented. Finally, in view of the potential for fast ambiguity resolution in undifferenced GNSS positioning, the limitations of existing GNSS data and products will be reviewed and possible avenues for further research and development proposed.

2B13.2 ID:3671 10:45

Developement of a MEMS-based INS/GPS System for Maritime Navigation Application

Mohammed El-Diasty , *Spiros Pagiatakis*
York University
Contact: eldiasty@yorku.ca

Global Positioning System (GPS) is currently recognised as a system which meets the requirements for position-fixing for maritime navigation. The maritime navigation requirement for radionavigation systems, such as GPS, performance is formed by the International Maritime Organization (IMO). To navigate safely, the pilot needs highly accurate verification of position almost continuously, together with information depicting any tendency for the vessel to deviate from its intended track. With standalone GPS system, continuous position-fixing is not guaranteed when an external interference or GPS outages exist. The integration of Inertial Navigation System (INS) with the current GPS system can provide an independent and self-contained navigation system, for a limited time period with GPS outages. INS and GPS are commonly being integrated to obtain accurate position, velocity, and attitude. The main factor that restricts the use of INS for a wide range of applications is the current high cost of precise inertial components. Over the last few years, a number of low cost Micro-Electro Mechanical Systems-based (MEMS) inertial sensors have been developed. Unfortunately, however, MEMS inertial sensor signals are contaminated by high-level noise and the navigation solutions drift significantly over time. The overall objective of this paper is to investigate the potential use and performance of MEMS-based Inertial Measurement Units (IMUs) integrated with GPS receiver for maritime navigation application. The paper included an analysis MEMS-based INS/GPS integration in four phases of a vessel's navigation: ocean, coastal, harbour approach and inland waterways. The focus is on the development of a MEMS-base INS/GPS integration system, so that the horizontal position accuracy can meet the IMO standards. To ensure that the MEMS-Based INS/GPS integration performs in an optimal way, the following new developments are investigated: (1) an accurate empirical model of low cost INS sensor errors (stochastic part) is developed using nonlinear wavelet network model; (2) a new frequency response model is developed to bridge GPS outages or interferences. To examine the performance of the proposed approach, dual frequency GPS data from Trimble BD950 receiver and inertial data from a low-end tactical grade MEMS-based IMU (DQI-100) and a low-cost consumer grade MEMS-based IMU (ADIS16364) are collected on board a vessel. The performance analysis of the new developments with the two potential MEMS-based IMUs is discussed in this paper.

2B13.3 ID:3734 11:00

A new technique in retrieving Total Electron Content and second-order ionospheric delays in radio occultation experiments using GPS

Panagiotis Vergados , *Spiros Pagiatakis*
York University
Contact: vergados@yorku.ca

The predominant error source in Global Positioning System (GPS) measurements is the ionosphere. Currently, GPS processing softwares, such as BERNESE and GYPSY only remove first-order ionospheric contributions from GPS observables achieving centimetre-level accuracy on ground-based GPS positioning. On radio occultations (RO) - when a Low Earth Orbiter (LEO) tracks a GPS satellite behind the Earth's limb - the retrieval of temperature profiles above ~35 km suffers from background ionospheric noise. In response to the increasing demands for accuracy improvements in positioning and atmospheric parameters estimation, the accurate retrieval of Total Electron Contents (TEC) and second-order ionospheric delays along GPS signals generate a growing interest in the scientific community.

Thus far, in RO experiments, TEC is retrieved by subtracting dual-frequency GPS observables, without accounting for the dispersive behaviour of the ionosphere and higher-order ionospheric effects. In this research, we propose a new linear combination for TEC estimation during RO experiments accounting both, for the dispersive behaviour of the ionosphere and second-order ionospheric effects.

Additionally, the second-order ionospheric effect is a function of both, the electron number density, and the geomagnetic field along the integrated signal path between a transmitter and a receiver. The standard method of computing second-order ionospheric errors makes use of ionospheric and geomagnetic field models. This research proposes to estimate the second-order ionospheric errors using the Faraday Rotation, which causes rotation of the polarization vector of the electromagnetic radiation changing its polarity. We first apply our technique in RO measurements. We find that the magnitude of the second-order ionospheric errors range between -0.8 cm and -1.5 cm. Correcting our GPS measurements from this effect, we can effectively achieve millimetre- level accuracy. Our proposed technique can also be applied to ground-based GPS measurements and improve both, the positioning accuracy and the temperature profiles above ~ 35 km in near-real time.

2B13.4 ID:4094 11:15

Optimal locations for GPS measurements in North America and northern Europe for constraining Glacial Isostatic Adjustment

Patrick Wu [1], *Holger Steffen* [1], *Hansheng Wang* [2]
[1] University of Calgary
[2] Chinese Academy of Sciences
Contact: ppwu@ucalgary.ca

We determine the optimal location in North America and Fennoscandia for uplift rate or tangential velocity data that will be useful for addressing ice sheet thickness, lithospheric thickness, lateral viscosity variation and background viscosity profile in the lower mantle. An optimal location is defined by where sensitivity lies above the current accuracy of GPS measurements. The approach here is different from previous studies that compute sensitivity kernels for viscosity perturbations within a small volume of the mantle. The advantage of the current approach is that the total effect of 3D lateral heterogeneity in the mantle related to seismic tomography of the whole mantle can be studied. The sensitivity of ice sheet models and lateral lithospheric thickness variations are also studied.

Our results show that in North America more permanent GPS stations are needed in northern Canada especially in a region west of the Hudson Bay until the Rocky Mountains. In Fennoscandia, the GPS network is almost adequate, but it should be extended to the last known GIA-affected areas in the Russian part of East Europe and to Central Europe. In addition, we show locations of prospective GPS sites that are sensitive to all four parameters (ice sheet thickness, lithospheric thickness, lateral viscosity variation and background viscosity profile in the lower mantle) and locations that are sensitive to only one, two or three parameters. Thus the results are useful for the inversion of one individual parameter or for the separation of the effects of two or more parameters in inversions.

2B13.5 ID:3699 11:30

GPS-derived corrections for secular gravity trends in Canada

Joseph Henton , *Thomas James* , *Jianliang Huang* , *Anthony Lambert* , *Michael Craymer* , *Stephane Mazzotti* , *Nicholas Courtier*
Natural Resources Canada
Contact: jhenton@NRCan.gc.ca

Since their launch in March 2002, the Gravity Recovery And Climate Experiment (GRACE) tandem satellites have provided monthly gravity field observations that provide unprecedented monitoring of terrestrial total water storage (TWS). However, secular trends in Canada's gravity field contain a significant signal resulting from the Earth's delayed viscoelastic response to the redistribution of mass following Pleistocene deglaciation. The resulting present-day glacial isostatic adjustment (GIA) signal appears as a 'trend' when viewed over 5 to 10 year time periods. Therefore, when assessing the secular trend of water content as measured by GRACE, it is first necessary to remove an estimate of the GIA trend which otherwise could incorrectly bias secular TWS change estimates by a few centimeters of equivalent water thickness. Although less sophisticated than GIA models, GPS uplift rates may be used to develop an empirical correction for GIA in much of central and eastern Canada. Following internationally accepted densification methodologies, weekly North American GPS solutions were combined into a single cumulative solution to provide estimates of both station coordinates and their velocities with respect to a consistent reference frame throughout North America. In order to provide an increased spatial sampling of crustal deformation throughout Canada, we have also estimated velocities at sites of the Canadian Base Network by combining over ten years of repeated multiple-epoch (episodic) GPS measurements. Using appropriate predictions of the ratio of gravity change rate to uplift rate, the GPS uplift rates are subsequently converted to predicted rates of change for surface gravity. Long-term absolute gravity trends may be used to validate the predicted surface gravity rates and the model-derived ratio of uplift rate to gravity rate. This empirical GIA correction can then used to correct GRACE observations to derive estimates of the rate of change of TWS for targeted regions in Canada.

2B13.6 ID:3727 11:45

Ground deformation in Taupo Volcanic Zone, New Zealand as observed by ALOS PALSAR interferometry

Sergey Samsonov [1], *Kristy Tiampo* [1], *Antonio Camacho* [2], *Jose Fernandez* [2], *John Beavan* [3]
[1] University of Western Ontario
[2] Instituto de Astronomia y Geodesia (CSIC-UCM)
[3] GNS Science
Contact: ssamson@uwo.ca

Ground deformations in the Taupo Volcanic Zone, a highly active back-arc region located in the central North Island of New Zealand, were mapped by the L-band ALOS PALSAR differential InSAR. We processed over 100 PALSAR images from three ascending and one descending tracks spanning from 01/2007 until 01/2010. Linear least square inversion technique was used to solve for deformation rates and the residual topographic noise simultaneously. Time series of ground deformation as well as linear deformation rates for the Taupo Volcanic Zone were calculated. Ground subsidence at Tauhara, Wairakei, Ohaaki and other geothermal fields was observed with rates close to 7 cm/year. Tectonic deformations were also observed, however, their interpretation is presently not clear. Modeling of deformation signals at the geothermal fields was performed solving for source location, depth and source strength.

CFCAS Achievements - The First Decade / Réalisations de la FCSCA - La première décennie

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Tim Aston), Date (02/06/2010), Time / Heure (10:30 - 12:00)

2B14.1 ID:4138 INVITED/INVITÉ 10:30

CFCAS Achievements - The First Decade

Dawn Conway , *Mcbean Gordon*
CFCAS/FCSCA
Contact: aston@cfcas.org

The Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) is celebrating 10 years of excellent research. Its support has reinvigorated atmospheric, oceanic and climate science in Canada, fostered partnerships and

helped train the next generation of climate and atmospheric scientists and oceanographers. CFCAS has funded more than 184 networks and projects – investing over $117 million in university-based research. Collaborations with scientists in other sectors have ensured that research results have been taken up and used, to the benefit of all Canadians. This session will highlight CFCAS's accomplishments, its influence on the scientific community and the impact of the funded work on operations, policy development and the well being of Canadians.

2B14.2 ID:3475 INVITED/INVITÉ 10:45

The Canadian Network for the Detection of Atmospheric Change (CANDAC) and the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut

James Drummond
Dalhousie University
Contact: james.drummond@dal.ca

In 2003 the news was bleak: The mothballing and possible demolition of the highest latitude ozone laboratory in Canada and the loss of the science and containing measurements at the site. At that time a number of us came together discuss how we could continue, and even expand on the measurements made. We recognised that an on-going measurement and analysis program were vital to our understanding of the atmosphere in general and the Arctic atmosphere in particular. Out of these discussions came the decision to form the Canadian Network for the Detection of Atmospheric Change (CANDAC) that would have a primary focus on retaining the Arctic measurements that were regarded as unique and vital to our ongoing endeavours.

Fast forward to 2010 and with support from a number of agencies - particularly in the form of a network grant from CFCAS - the renamed Polar Environment Atmospheric Research Laboratory (PEARL) is open 365 days a year performing internationally recognised research on the atmosphere up to 100km altitude. With many ongoing projects, national and international collaborations, and a suite of over 25 permanent instruments as well as guest instruments, PEARL is a highly active and productive endeavour. This talk will give an overview of the latest research at PEARL and the prospects for ongoing research on the atmosphere and, now that PEARL is established as a research base, in other areas of science.

CANDAC/PEARL funding partners are: the Arctic Research Infrastructure Fund, Atlantic Innovation Fund/Nova Scotia Research Innovation Trust, CFCAS, Canadian Foundation for Innovation, Canadian Space Agency, Environment Canada, Government of Canada International Polar Year, Natural Sciences and Engineering Research Council, Ontario Innovation Trust, Ontario Research Fund, Indian and Northern Affairs Canada, and the Polar Continental Shelf Program

2B14.3 ID:3352 INVITED/INVITÉ 11:00

The Canadian Carbon Program and Fluxnet-Canada: Advancing Our Understanding of the Carbon Cycle of Canada's Forests and Peatlands Using a Research Network Approach

Hank Margolis [1], *Harry Mccaughey* [2]
[1] Université Laval
[2] Queen's University
Contact: Hank.Margolis@sbf.ulaval.ca

Eddy covariance flux towers measure the exchanges of carbon dioxide, water, and heat between ecosystems and the atmosphere. They are valuable tools for understanding and predicting the impacts of climate variability, disturbance, and land-use change on the terrestrial carbon cycle. In 2002, CFCAS in concert with other funding partners supported the establishment of an east-west continental-scale transect of approximately 30 flux towers that encompass many of North America's important northern forest ecoregions and disturbance regimes. These towers are now complemented by high-precision atmospheric concentration measurements at several sites. Flux tower networks make a key contribution to the development of the scientific concepts, tools, data bases, models, and decision support capabilities required to build an integrated carbon observation and prediction system. The influence of forest harvest, fires, insects, and nutrient addition are being studied and the multi-year records along chronsequences in different regions permit us to extrapolate our results to regional, national and continental scales as well as to propose strategies for integrating inter-annual climate variability into an inventory-based forest carbon accounting system. Our data has also been useful for developing satellite remote sensing tools for monitoring forest physiology and structure at large spatial scales. Furthermore, our participation in global synthesis efforts has allowed our data sets to contribute to circumpolar and global scale syntheses.

2B14.4 ID:3666 INVITED/INVITÉ 11:15

Recent Advances in Ocean Modelling and Data Assimilation

Keith Thompson [1], *Hal Ritchie* [2]
[1] Dalhousie University
[2] Environment Canada
Contact: keith.thompson@dal.ca

The Canadian Foundation for Climate and Atmospheric Sciences has funded the Global Ocean-Atmosphere Prediction and Predictability (GOAPP) research network for almost four years. The network has brought together ocean and atmospheric researchers from across Canada to improve forecasts of the ocean and atmosphere on time scales from days to decades, and space scales of tens to tens of thousands of kilometers. In addition to better prediction systems, the network is also producing a new generation of interdisciplinary research

scientists capable of bridging the gaps created by different time scales of variability (weather and climate) and scientific discipline (oceanography and atmospheric science). An important part of GOAPP's research effort has been the development of ocean models and assimilation schemes that are now being used to predict intra-seasonal variability on both ocean basin (North Atlantic and North Pacific) and global scales, and also to downscale variability from the deep ocean to continental shelf seas. This presentation will illustrate some of the main achievements of GOAPP researchers related to ocean modeling and assimilation, show how the results are leading to improved coupled atmosphere-ocean predictions, and conclude with some comments on the training of highly qualified personnel. This presentation is given on behalf of the 18 GOAPP co-investigators and their research associates, postdoctoral fellows, graduate students and technicians.

2B14.5 ID:3596 INVITED/INVITÉ 11:30

CFCAS funded research and Environment Canada: Collaboration and benefits

Charles Lin
Environment Canada
Contact: carrie.lillyman@ec.gc.ca

There has been a record of strong collaboration between university researchers funded by CFCAS and Environment Canada (EC) scientists. The latter are located mainly in the Atmospheric Science and Technology Directorate, with some in the Water Science and Technology Directorate. EC is the federal department with the largest rate of participation as measured by the number of co-investigators in CFCAS Networks and Projects. The statistics are impressive. EC scientists participate as co-investigators in 21 out of 24 Networks, and 35 out of 174 Projects. Of the current 12 active Networks, 10 have EC scientists as co-investigators, with EC representation on the Board of Directors in 11 of these networks. We present an overview of the collaboration of EC and university scientists in current and past Networks and Projects and the benefits to EC. These Networks and Projects have played a critical role in enhancing EC capabilities in different areas, including seasonal to interannual forecasting, middle atmosphere modelling, carbon cycle studies and regional climate modelling.

Atmosphere, Ocean, and Climate Dynamics (Part 1) / Dynamiques de l'atmosphère, de l'océan et du climat (Partie 1)

Room / Endroit (Richelieu), Chair / Président (Adam Monahan), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C04.1 ID:3857 14:00

Wind Channeling in the St. Lawrence River Valley

Alissa Razy , *Eyad Atallah* , *John Gyakum*
McGill University
Contact: alissa.razy@mail.mcgill.ca

Winds blowing in the St. Lawrence River Valley (SLRV) are prone to channeling along the valley axis, which is generally oriented northeast/southwest. Channeling refers to processes that force the wind to blow along a valley's axis, regardless of the wind direction above ridge height (Kossmann and Sturman 2003). The island of Montreal, the most populated city in the SLRV, sits in a slightly bent section of the valley that runs northeast/west-southwest. To better understand channeling effects, surface data from Trudeau Airport in Montreal (CYUL) of observed winds is being studied in conjunction with data derived using the North American Regional Reanalysis produced by the National Centers for Environmental Prediction. Carrera et al. (2009) present preliminary conclusions concerning the physical processes associated with winds channeled in the SLRV, but note that further investigation is required. In particular, there is a need to classify conditions that lead to various situations of channeled winds (or lack thereof) in order to improve forecasting of potentially damaging weather events (e.g. freezing rain, wind forecasting for aviation purposes, improved precipitation prediction including mesoscale banded precipitation). Interestingly, despite the prevalence of clear channeling effects in the SLRV, there are also periods of sustained cross-valley winds (e.g. southeasterly winds). Accordingly, the work presented here builds on the work of Carrera et al. (2009) by identifying characteristic patterns at the local, mesoscale and synoptic scales that accompany various wind regimes – both channeled and cross-valley winds.

References: Carrera, M. L., J. R. Gyakum, and C. A. Lin, 2009: Observational study of wind channeling within the St. Lawrence River Valley. Journal of Applied Meteorology and Climatology, 48, 2341-2361.

Kossmann M., and A. P. Sturman, 2003: Pressure-driven channeling effects in bent valleys. Journal of Applied Meteorology, 42, 151–158.

2C04.2 ID:3738 14:15

The deepening of cumulus convection by moisture preconditioning

Michael Waite [1], *Boualem Khouider* [2]
[1] University of Waterloo
[2] University of Victoria
Contact: mwaite@uwaterloo.ca

Cloud-resolving numerical experiments will be presented that explore the connection between environmental moisture and deepening cumulus convection. There is a two-way relationship between background humidity and cloud deepening: clouds can modify the moisture of their environment, while enhanced moisture may reduce dry-air entrainment and lead to deeper clouds. In this work, we investigate and quantify these processes in idealized numerical simulations of deepening cumulus clouds. The initial state is chosen to be favourable for shallow convection, which is excited through surface fluxes and radiative cooling. However, in the absence of large-scale subsidence, these shallow clouds grow into congestus and ultimately deep convection. Moistening in the lower troposphere is shown to result from the detrainment of water vapour from congestus clouds, and we argue that this moistening largely accounts for the transition to deep convection. A number of sensitivity tests will be presented that analyze the dependence of cloud depth on the background thermodynamic profiles and sub-grid scale mixing. The implications of these findings for large-scale simulations in which resolved mixing is reduced will also be discussed.

2C04.3 ID:3970 14:30

Heating effects of a vertically size-dependent lognormal dust distribution in a column model of the Martian atmosphere

Jennifer Mclarty , *John C. Mcconnell*
York University
Contact: mclarty@yorku.ca

Atmospheric dust is important for heating the Martian atmosphere planetary boundary layer. For this study we investigate the transfer of radiation in a simple column model of a scattering, absorbing and emitting Martian dust atmosphere without CO2 absorption. An inhomogeneous atmosphere composed of individual homogeneous layers is assumed by specifying a vertically size-dependent lognormal dust distribution. The dust optical properties in this study are a function of height since the dust extinction efficiency varies with the dust mean-radius over altitude. For each layer we used the two-stream delta-Eddington approximation with scattering and absorption as the shortwave source function and the Planck function as the infrared source function. The shortwave and longwave radiative heating rates of the lognormal dust distribution are then solved using the standard tridiagonal method. A comparison will be presented between these results and the radiative transfer solution to a size-independent vertical distribution of dust in which dust optical properties are height independent and the optical thickness of each layer is a projection of the surface optical thickness.

2C04.4 ID:3598 14:45

Gravity-wave mean-flow interactions in a model with intermittent forcing

Lucy Campbell [1], *Kristopher Rowe* [2]
[1] Carleton University

[2] University of Waterloo
Contact: campbell@math.carleton.ca

Interactions between atmospheric gravity waves and the background mean wind give rise to momentum deposition, mean-wind acceleration and descending shear zones, and hence play a role in driving phenomena such as the quasi-biennial oscillation (QBO) in the equatorial stratosphere. In implementing gravity wave drag parameterization schemes in atmospheric models, the calculated drag is generally multiplied by a loosely-constrained constant, referred to as the intermittency factor, in order to reflect the fact that gravity wave sources are intermittent and that the waves are only forced over a certain fraction of time. In simulations of the QBO using parameterized gravity wave drag the value of this constant can be adjusted to produce a QBO with a realistic period. In this presentation we describe a simple model for the QBO in which the constant intermittency factor is replaced by a random variable so that the wave forcing actually varies intermittently with time, and we compare our results with those obtained with a constant time-independent forcing.

2C04.5 ID:3509 **15:00**

Internal Gravity Waves Forced By An Isolated Mountain

Lidia Nikitina [1], *Lucy Campbell* [2]
[1] PhD student Carleton University, School of Mathematics and Statistics
[2] Associate Professor Carleton University, School of Mathematics and Statistics
Contact: lnikitina@sympatico.ca

Density-stratified fluid flow over topography such as mountains, hills and ridges may give rise to internal gravity waves which transport and distribute energy away from their source and have profound effects on the general circulation of the atmosphere and ocean.

In this study, both analytical and numerical methods are used to examine the nonlinear dynamics of gravity waves forced by an isolated mountain. The topography is represented by a lower boundary condition on a two- dimensional rectangular domain and the waves are represented as a perturbation to the background shear flow, thus allowing the use of weakly-nonlinear and multiple-scale asymptotic analyses. The waves take the form of a packet, localized in the horizontal direction and comprising a continuous spectrum of horizontal wavenumbers centered at zero. For horizontally-localized wave packets, such as those forced by a mountain range with multiple peaks, there are generally two horizontal scales, the fast (short) scale which is defined by the oscillations within the packet and the slow (large) scale which is defined by the horizontal extent of the packet. In the case of an isolated mountain that we examine here, the multiple-scaling procedure is simplified by the absence of a fast spatial scale. The problem is governed by two small parameters that define the height and width of the mountain and approximate solutions are derived in terms of these parameters. Numerical solutions are also carried out.

It is found that for waves forced by an isolated mountain the time frame within which the nonlinear effects become significant depends on both the mountain height and width and that they begin to occur at least an order of magnitude later and the configuration thus remains stable longer than in the case of waves forced by a mountain range of equivalent height.

2C04.6 ID:3309 15:15

Resonant reflection of forced waves in weakly nonhydrostatic models

Marek Stastna
University of Waterloo
Contact: mmstastn@uwaterloo.ca

It is well known that the reflection of many common wave types in geophysical fluid dynamics does not obey Snell's law. In this talk I will consider the case of forced waves, for example due to wind. I will demonstrate that because the forced waves do not satisfy the dispersion relation of free waves, the reflected waves do not obey Snell's law, even for the simplest case of linear, nondispersive waves. I will subsequently present simulations of wind forced weakly nonhydrostatic shallow water equations. These clearly show dominant reflected packets for certain parameter regimes. I will discuss to what extent these can be predicted theoretically and the importance of nonlinear effects.

Operational Oceanography: observations, modelling and data assimilation (Part 2) / Océanographie opérationnelle : observations, modélisation et assimilation des données (Partie 2)

Room / Endroit (Frontenac), Chair / Président (Gregory Smith), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C05.1 ID:3361 14:00

Tidal applications using the NEMO model, including two-way nesting

Frederic Dupont [1], *Zeliang Wang* [2], *Charles Hannah* [2], *Fraser Davidson* [3], *Dan Wright* [2]
[1] Environment Canada
[2] DFO, Bedford Institute of Oceanography

[3] DFO, Northwest Atlantic Fisheries Centre
Contact: frederic.dupont@dal.ca

As NEMO (Nucleus for European Modelling of the Ocean) becomes the next generation community model at the Canadian Department of Fisheries and Oceans and Environment Canada, many wonder if this model is appropriate for shelf applications including tides. We will show the modifications we implemented in the code to allow for tidal propagation and some special treatments of the linear free surface and to the AGRIF routines used for the two-way nesting. With these modifications, the model appears to be propagating tides correctly, however some challenges remain regarding the use of a nonlinear free-surface that more recent or future versions of NEMO may resolve.

2C05.2 ID:3484 14:15

The influence of tides and fresh water input on simulated sea ice distributions in the Northwest Atlantic

Maud Guarracino [1], *Fred Dupont* [2], *Fraser Davidson* [3], *Charles Hannah* [1], *Andry Ratsimandresy* [3], *Zeliang Wang* [1]
[1] Bedford Institute of Oceanography
[2] Environment Canada
[3] DFO, Northwest Atlantic Fisheries Centre
Contact: maud.guarracino@dfo-mpo.gc.ca

C-NOOFS (Canada Newfoundland Operational Ocean Forecast System) is a pre-operational ice-ocean prediction system for the Northwest Atlantic being developed for eventual operational application as part of a coupled atmosphere-ice-ocean prediction system at Environment Canada's Canadian Meteorological Centre. We report on upgrades to the physical forcing included in the model simulations. Tidal forcing (M2 only) and fresh-water input from rivers (monthly climatology) have been added. Sensitivity studies for the years 2006-2009 examine changes to the freshwater budget and the impact of tidal mixing of the water column. The focus is on the impact on the space-time evolution of the sea ice distributions in the northwest Atlantic.

2C05.3 ID:4165 14:30

Influence of diurnal forcing on operational forecasts of surface conditions in the northwest Atlantic Ocean.

Nathalie Toqué [1], *David Straub* [1], *Greg Smith* [2], *Fraser Davidson* [2]
[1] McGill University, Atmospheric and oceanic sciences Dept.
[2] Fisheries and Oceans Canada, NAFC
Contact: n_toque@yahoo.ca

The Canada-Newfoundland Operational Ocean Forecast System (C-NOOFS) uses observations and realistic modelling to forecast conditions in the northwest Atlantic Ocean on short time scales (e.g., several days). To this end, the ocean-sea ice model NEMO will be coupled to the Environment Canada meteorological forecast model, GEM. As a first step, we report on simulations of NEMO over the northwestern Atlantic using near real time wind forecasts from Environment Canada. We are particularly interested in how the temporal resolution of the forcing fields (wind; solar insulation; atmospheric temperature) affect ocean fields such as sea surface temperature (SST). For example, it has been suggested that a diurnal cycle in short wave radiation affects daily averages of SST, even at midlatitudes where the diurnal cycle is less pronounced and can be reduced in meteorological conditions such as overcast skies. We will thus investigate how forecast error growth is affected by the degree to which the diurnal cycle is resolved in the forcing fields for short term ocean forecasts in the northwest Atlantic and at different times of the year.

2C05.4 ID:3640 14:45

A Study of Long-term Marine Surface Winds in Offshore Areas of the Canadian Beaufort Sea

David Fissel , *Nilgun Kulan*
ASL Environmental Sciences Inc.
Contact: dfissel@aslenv.com

The marine winds in offshore portions of the Canadian Beaufort Sea are important to the resumed exploration for oil and gas resources in this area. As well as the importance in their own right, in terms of design of platforms and operations, the winds are an important determinant of local waves and currents and the movement of sea-ice.

The availability of direct marine wind observations in this offshore region is limited to occasional measurements in the early 1980's as well as occasional data collection from ships operating in this area. NCEP/NCAR Reanalysis-2 wind field data are also available for the past 30 years and an Environment Canada (EC) wind-wave hindcast study provides wind data for the period 1985 to 2005. The model-derived NCEP/NCAR and Environment Canada winds were compared with the limited direct observations to assess their accuracy and representativeness for this study. In this paper, we examine trends in summer wind conditions, including average and maximum wind speeds and the modal directional distributions, on the outer continental shelf and slope regions of the Canadian Beaufort Sea. The interannual variability of the winds is very large which leads to uncertainties in the statistical significance on the derived trend results. The statistical properties of the offshore surface winds differ significantly from the inshore and coastal winds recorded at the Environment Canada weather stations for Pelly Island and Tuktoyaktuk. The implications of the long-term distributions and trends in marine surface winds for the offshore areas are discussed in terms of their effects on waves, currents and ice velocities.

2C05.5 ID:3634 15:00

Forecasting of drifters using CANSARP in the Newfoundland Basin

Sanjay Rattan , *Syd Peel* , *Hal Ritchie*
Environment Canada
Contact: sanjay.rattan@ec.gc.ca

GEM (Global Environmental Multiscale) regional and global model wind forecasts have been used to force the CANSARP-Scientific (CANadian Search And Rescue Program) MATLAB model to determine the likely positions of drifters (such as people and weight dependent rafts, sailboats and individual persons floating on water). The present CANSARP model search area determination is based on characteristics of drifters, atmospheric drag forces (wind forcing), and oceanic drag forces (seasonal currents, tidal currents, barotropic and baroclinic currents). The spatial distribution of the search area error is calculated from a combination of probabilistic drift error, initial position error and search craft error. As far as the wind forcing is concerned, it acts on the drifter movement in two ways: directly through leeway (wind acting on exposed surface of drifters and causing drift), and indirectly through the resulting barotropic currents (which is empirically determined as 3.3% magnitude of wind velocity and rotated 20 degrees to the right). In this study the regional and global GEM configuration wind outputs are used to evaluate the performance of CANSARP in forecasting position of drifters over time. The outputs are validated against field experiments from 2004-2005 obtained in the Newfoundland basin. A few selected case studies are presented to show the improvement in forecasting in using high resolution regional GEM outputs over lower resolution global outputs.

2C05.6 ID:3937 15:15

Analysis of oceanographic data measured by pinnipeds and of their contribution to the global observing system

Mathieu Ouellet [1], *Fraser Davidson* [2], *Garry Stenson* [2], *Mike Hammil* [3]
[1] ISDM-DFO
[2] NAFC-DFO
[3] IML-DFO
Contact: mathieu.ouellet@dfo-mpo.gc.ca

The use of diving marine animals as autonomous profilers started in the 1990s (Boyd et. al, 1999) but the methods for analysing the collected data are still under development. The measurement of salinity by such devices only began in the 2000s. Here we analyse unpublished temperature and salinity data measured by 90 autonomous pinniped environmental samplers. The measurements cover portions of the North Atlantic, Canadian Arctic, Gulf of St. Lawrence and Hudson Bay System, between 2003 and 2008. Positions, temperature and salinity were transmitted in real-time.

New quality control tests to flag errors on position are proposed, building on «classical» oceanographic sampling platforms guidelines. Tests for valid position, for instance, can take into account swimming capacity and diving patterns

instead of average speed. Thresholds for such tests will be examined and objective analysis performed on data archived in the Integrated Science Data Management (ISDM) archives of Fisheries and Oceans will be used to analyse and quality control the profile data.

Just like drifters and Argo-type profilers, sampling pinnipeds do not randomly sample the environment. Neither do they sample according to a predefined pattern the way a ship can do. It will be shown that their contribution is however important since they visit areas otherwise infrequently sampled by drifters and Argo-type profilers, which tend to follow currents and stay away from divergence zones and/or shallow zones. The contribution to the global ocean observing system of those pinnipeds and of those whose data are transmitted in real-time on the Global Telecommunication System will be quantified and shown.

General Hydrology Session (Part 2) / Séance générale sur l'hydrologie (Partie 2)

Room / Endroit (Joliet), Chair / Président (Sean Carey), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C06.1 ID:3691 **14:00**

Geostatistical modeling of a heterogeneous deltaic aquifer system

Martin Blouin , *Richard Martel* , *Erwan Gloaguen*
INRS-ETE
Contact: martin.blouin@ete.inrs.ca

In groundwater assesment studies, the heterogeneity of quaternary deposits is the main driver of groundwater flow and mass transport. Paleo-deltaic environments shows high variability in stratigraphic facies continuity and high hydraulic properties contrasts. Conventional hydrogeological numerical modeling consists in interpolating by hand the different units intercepted at sampled wells guided by geological knowledge. This approach is time consuming and, also, user dependent. Because of these reasons, only one smooth model is generated. The smooth model produced by conventional modeling implies that the heterogeneity of the ground is not reproduced leading to local over or under estimation of mass transport. The global effect of such smoothing cannot be a priori estimated. The approach proposed in this study aims at developping probabilistic mass transport characterization in a heterogeneous deltaic environment. It uses geostatistical simulations, a method that is increasingly used in heterogeneous systems modeling, to generate multiple statistically equivalent high resolution geological models that will help characterizing the aquifer heterogeneity and evaluate the uncertainty on the groundwater flow and mass transport modeling. A 3-D conceptual geological model is first produced based on surface geology, boreholes information, geological knowledge and geophysical surveys. Starting with the conceptual model and the well data, a multiple-point simulation is used to produce several statistically equivalent scenarios describing the geological uncertainty. Within each stratigraphic domain, hydraulic properties are simulated using conventional sequential Gaussian simulation according to the facies property range and measured hydraulic conductivity within each hydrogeological units. Among all the scenarios, the most reliable ones are then chosen and used as an input in a hydraulic FEFLOW model. A variability map showing zones with the largest uncertainty is built as well as a contamination probability scheme. These tools provide essential information regarding further characterization and/or give tools to the decision makers for rehabilitaion strategies.

2C06.2 ID:3331 14:15

Evaluating seasonal soil water dynamics using high-frequency ground-penetrating radar

Colby Steelman , *Anthony Endres*
University of Waterloo
Contact: cmsteelm@uwaterloo.ca

High-frequency ground-penetrating radar (GPR) surveys were used to investigate temporal water content variations in a vertical soil column characterized by stratified clean sand deposits over multiple annual cycles. Reflection profiling and common-midpoint (CMP) soundings were coincidently performed using 900 MHz antennas across a 2 m intensive monitoring profile. Our ability to identify fixed reflection events along a vertical soil profile permits inference of soil water flux across defined soil intervals in a non-invasive manner. Soil moisture contents were estimated from two-way traveltime measurements between seasonally coherent stratigraphic interfaces in the upper 2–3 m of soil. Interval thicknesses between stratigraphic interfaces were estimated from normal-moveout velocity analysis of coincidently collected CMP soundings. Interval traveltimes from reflection profiles were then converted to wave velocity using the interval thickness estimates and a volumetric water content estimate using an appropriate petrophysical relationship. The GPR effectively characterized long (e.g., seasonal trends) and short-period (e.g., distinct wetting events) variations in vertical soil moisture distribution.

2C06.3 ID:3924 14:30

A two-step assimilation framework to improve soil moisture data

Gift Dumedah [1], *Aaron Berg* [1], *Mark Wineberg* [2]
[1] Department of Geography, University of Guelph
[2] Department of Computing and Information Science, University of Guelph

Contact: gdumedah@uoguelph.ca

Soil moisture data are an important requirement for hydrological and weather forecasting models. Due to expensive nature of soil moisture ground networks, satellite observation platforms have been used to provide soil moisture data, particularly, for large and remote areas. Generally, satellite soil moisture data are indirectly generated from satellite brightness temperature, and they are limited to the top 5cm layer of the earth surface. Given the indirect estimation, the retrieved surface soil moisture data usually have variable accuracy depending on the retrieval algorithm used. In practice, users also require soil moisture information for deeper soil layers. Given these challenges, satellite soil moisture data are usually assimilated with soil moisture data generated from land surface models. But a simultaneous assimilation of both satellite brightness temperature and soil moisture has not been thoroughly investigated.

This presentation will demonstrate a joint assimilation framework for satellite brightness temperature and soil moisture using a multi-objective genetic algorithm. The framework provides an improved soil moisture data by combining two imperfect soil moisture datasets, one derived from satellite brightness temperature, and the other generated from a land surface model using the Canadian Land Surface Scheme (CLASS). The two-step assimilation framework has been demonstrated to increase the quality of two datasets before they are assimilated into an improved soil moisture data. Application of our framework to the Brightwater Creek watershed in Saskatchewan illustrates the utility of our joint assimilation framework to improve a time series of soil moisture data. The stochastic capability and in-built memory of the assimilation framework are appealing as they can facilitate the estimation of soil moisture data in real-time when satellite information becomes available.

2C06.4 ID:3783 14:45

Improved prediction of soil moisture using a physical basis for spatial averaging of synthetic aperture radar data

T.s. Gala [1], *I.f. Creed* [2]
(Presented by *Tekleab Gala*)
[1] Department of Geography, University of Western Ontario, London, Ontario, Canada
[2] Department of Biology, University of Western Ontario, London, Ontario, Canada
Contact: tgala2@uwo.ca

Soil moisture is notoriously variable in space and time which makes extrapolating point measurements difficult. Direct mapping of soil moisture using radar imagery holds promise because it can capture spatially distributed soil moisture day and night, regardless of weather. However, even within relatively flat landscapes (<10° slope), the use of radar imagery is limited because of enhanced backscatter from topographic features. In this study we tested whether selection of spatial averaging schemes of radar images would effect extraction of soil moisture data. Soil moisture data were collected during the snow-free period

(May – October) from four parcels of land (900 m x 1600 m) along a moisture deficit gradient (ranging from -270 mm/yr to -520 mm/yr) within the Prairie Pothole Region of Saskatchewan at intervals coincident with RADARSAT-1 satellite overpass. The relationship between soil moisture content and the radar backscatter coefficient varied with spatial averaging scheme determined from a 2.5 m × 2.5 m LiDAR DEM. The relationship improved with increasing area of spatial averaging from a point (r2 = 0.20; p<0.001), to the drainage basin of a pothole (r2 = 0.40; p<0.001), to the entire parcel (r2 = 0.51; p<0.005). However, the strongest relationship (r2 = 0.80; p<0.001) was obtained with spatially averaged images based on topographic position (uplands, side-slopes, and lowlands). Soil moisture maps obtained by inverting RADARSAT-1 data with the model that used topographically based averaging captured the spatial and temporal variation of soil moisture in a validation dataset (r2=0.74; p<0.001). These findings indicate that topographically based averaging of RADARSAT-1 imagery can be used to predict soil moisture dynamics in prairie pothole landscapes.

Keywords: soil moisture, hydrology, synthetic aperture radar (SAR), RADARSAT-1, LiDAR, prairie pothole

2C06.5 ID:3741 **15:00**

CoReH2O, an ESA radar satellite mission dedicated to cold regions hydrology

Claude Duguay [1], *Helmut Rott* [2], *Don Cline* [3], *Richard Essery* [4], *Pierre Etchevers* [5], *Irena Hajnsek* [6], *Michael Kern* [7], *Giovanni Macelloni* [8], *Eirik Malnes* [9], *Jouni Pulliainen* [10], *Simon Yueh* [11], *Florence Hélière, Arnaud Lecuyot* [7]
[1] University of Waterloo
[2] University of Innsbruck, Austria
[3] NOAA-NOHRSC, USA
[4] University of Edinburgh, UK
[5] Météo France, France
[6] DLR-HR, Germany
[7] ESA-ESTEC, Netherlands
[8] IFAC-CNR, Italy
[9] NORUT Tromsö, Norway
[10] FMI, Finland
[11] JPL-CalTech, USA
Contact: crduguay@fes.uwaterloo.ca

The satellite mission COld REgions Hydrology High-resolution Observatory (CoReH2O) has been selected for scientific and technical feasibility (Phase A) studies within the Living Planet Programme of the European Space Agency (ESA). The mission will provide spatially detailed dual-frequency synthetic aperture radar (SAR) measurements of snow and ice in order to advance our knowledge and predictive capabilities of the water cycle in cold regions and to improve the representation of the cryosphere in climate models. The proposed sensor will operate at Ku-band (17.2 GHz) and X-band (9.6 GHz), VV and VH

polarizations. For the first two years of the mission, a three-day repeat cycle with a spatially-limited coverage is proposed, in order to match the time scale of meteorological forcing, particularly addressing the parameterization of snow and ice processes in hydrological models and in regional atmospheric circulation models. During this phase the intent is to perform intensive campaigns and studies in test basins of different snow regimes around the world. The second mission phase shall provide near complete observations of the global cryosphere at a repeat cycle of about 12-15 days. The primary parameters to be delivered by the CoReH2O mission are spatially detailed observations of snow extent, water equivalent (SWE) and melting state of the seasonal cover, as well as snow accumulation on glaciers. Theoretical and experimental work has been focusing on the interactions of Ku- and X-band radar backscatter with snow and ice, and on the development of methods for the retrieval of physical snow properties. Field campaigns are conducted in winter 2009/10 in northern Finland and Canada employing ground-based Ku- and X-band scatterometers, and in Colorado with the airborne PolScat of NASA/JPL operating at Ku-band complemented by X-band SAR data acquired by the TerraSAR-X satellite in order to further augment the experimental data base for improved SWE retrieval. This paper will provide an overview of the CoReH2O satellite mission and highlight key results from the recent field campaigns.

2C06.6 ID:4070 15:15

Water Cycle Contributions to the Global Earth Observation System of Systems (GEOSS)

Richard Lawford
University of Manitoba
Contact: lawfordr@cc.umanitoba.ca

The Group on Earth Observations (GEO), which consists of approximately 80 nations and 50 international organizations, is developing the Global Earth Observation System of Systems (GEOSS). GEOSS will be a blend of diverse national and disciplinary observing and information systems that will be interoperable and implement agreed-upon standards, protocols and policies related to data and information sharing. In developing this System of Systems GEO supports initiatives in nine Societal Benefit Areas including agriculture, biodiversity, climate, ecosystems, energy, health, natural disasters, water, and weather. In addition, GEO addresses crosscutting topics such as science and technology, data systems, user interactions and capacity building. This talk will provide an overview of the GEO Water Societal Benefit Area. Water-related activities in these areas will be highlighted: integrated data sets, drought monitoring, capacity building, convergence to data system interoperability, and communities of practice. It will also introduce interested experts to ways in which they could become more actively involved in GEO.

The upper troposphere and lower stratosphere (UTLS) (Part 1)/ Haute troposphère et basse stratosphère (HTBS) (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Michel Bourqui), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C07.1 ID:3752 INVITED/INVITÉ 14:00

Recent widening of the tropical belt from global tropopause statistics

Thomas Birner
Department of Atmospheric Science, Colorado State University
Contact: thomas@atmos.colostate.edu

Several recent studies have shown evidence for a widening of the tropical belt over the past few decades. One line of evidence uses statistics of tropopause height to distinguish between tropics and extratropics and defines tropical edge latitudes as those latitudes at which the number of days per year with tropopause height greater than 15 km exceeds a certain threshold (typically 200 days/year). This definition involves two somewhat arbitrary thresholds. Here the sensitivity of the resulting widening trend of the tropical belt to changes in these thresholds is investigated using four different reanalysis data sets. Widening trends are found to be particularly sensitive to changes in the tropopause height threshold. Furthermore, trend estimates from different reanalysis data sets are found to be mostly inconsistent with each other. In the case of the NCEP/NCAR reanalysis even slight modifications to the tropopause definition lead to large changes in the widening trend. Ways to objectively determine appropriate thresholds to define tropical edge latitudes based on tropopause statistics are presented. Possible causes for the discrepancies in the trend estimates from the different reanalysis data sets will be discussed.

2C07.2 ID:3951 14:30

Fine structure of the global tropopause

Seok-Woo Son [1], *Neil Tandon* [2], *Lorenzo Polvani* [2]
[1] McGill University
[2] Columbia University
Contact: seok-woo.son@mcgill.ca

The spatio-temporal structure of the global tropopause is examined using high-resolution COSMIC/FORMOSAT-3 GPS RO observations. Based on the WMO-defined thermal tropopause, the seasonal cycle and intra-seasonal variability of

tropopause pressure (Tp), temperature (Tt) and sharpness (Ts) are calculated, and overall results are compared with quality-controlled radiosonde observations and the NCEP-NCAR reanalysis data. It is found that, while the tropopauses in the GPS RO and radiosonde observations are quantitatively similar, those in the reanalysis data misrepresent some of basic features of the extratropical tropopause.

The GPS RO data captured the structure of the global tropopause in remarkable details. In the tropics, Tp and Tt are largely homogeneous in space. A significant zonal structure however is found in the northern extratropics: e.g. a stationary wave pattern in boreal winter and an Asian-monsoon anticyclone signal in boreal summer. In the southern extratopics, tropospause is zonally symmetric in both seasons. Most of these characteristics are closely related with tropospheric circulations. An exception is the southern extratropical tropopause in austral winter: Tp and Tt are strongly affected by stratospheric polar vortex. Intraseaonal variability further showed that Tp and Tt are modulated by extratropical storm activities, variability over the Asian summer monsoon, and the occurrence of double tropopauses in the subtropics. Variability in the tropics, however, is found to be minimal.

In contrast to Tp and Tt, Ts shows zonally symmetric pattern in all seasons and at almost all latitudes except over the Northern Hemisphere storm-track regions. Ts is generally sharper in the tropics than in the extratropics, and sharper in the summer hemisphere than in the winter hemisphere. The latter seasonality is likely associated with water vapor in the lowermost stratosphere. It is also found that the intraseasonal variability of Ts has maximum in the tropics and in the extratropical storm-track regions.

2C07.3 ID:3661 **14:45**

The static stability of the tropopause region in baroclinic life-cycle experiments

Andre Erler [1], *Volkmar Wirth* [2]
[1] University of Toronto
[2] University of Mainz
Contact: aerler@atmosp.physics.utoronto.ca

The Tropopause Inversion Layer (TIL) is a region of enhanced static stability just above the tropopause. It is an ubiquitous feature of the mid–latitude tropopause and is well characterized by observations; however it is still lacking a satisfying theoretical explanation. This study uses adiabatic baroclinic life–cycle experiments to investigate dynamical mechanisms that lead to the formation of a TIL. Consistent with previous results, as soon as the baroclinic wave grows, a strong TIL forms above anti–cyclonic vorticity anomalies, while no TIL is found above cyclonic anomalies. However, during the early growth phase the TIL does not appear in the global and zonal average. It only emerges in the zonal and global mean after the wave–breaking event; when no wave–breaking occurs, no

TIL forms (in averaged profiles). The strength of the zonal mean TIL appears to be associated with the separation of the dynamical and thermal tropopause; furthermore a significant rise of the thermal tropopause can be observed in LC1–type life–cycles. In contrast, the dynamical tropopause does not rise signicantly in any life–cycle configuration and does not exhibit a TIL in the global mean. The results of these experiments are interpreted in terms of earlier results on cyclone / anti–cyclone asymmetry and nonlinear effects in PV inversion. The analysis suggests that the TIL (as a global mean feature) is linked to a strongly asymmetric distribution of cyclonic and anticyclonic anomalies, which occurs after the wave breaking event.

2C07.4 ID:3872 15:00

Characterizing the Seasonal Variation in Position and Depth of the Mixing Layer in the UTLS Based on Observations from the ACE-FTS and TES Satellite Instruments

Dave Mackenzie[1], *Dylan Jones*[1], *Michaela Hegglin*[1], *John Worden*[2], *Chris Boone*[3], *Kaley Walker*[1], *Peter Bernath*[4], *Claire Carouge*[5], *Lee Murray*[5]
[1] University of Toronto
[2] Jet Propulsion Laboratory
[3] University of Waterloo
[4] University of York
[5] Harvard University
Contact: davem@atmosp.physics.utoronto.ca

Tropospheric ozone plays an important role in determining the oxidative capacity of the troposphere. It also impacts air quality and is a greenhouse gas. Changes in the abundance of ozone in the upper troposphere and lower stratosphere (UTLS) are of particular concern as it is in this region of the atmosphere that ozone contributes most strongly to the radiative forcing of the climate system. We use the GEOS-Chem model together with observations from the Tropospheric Emission Spectrometer (TES) and the Atmospheric Chemistry Experiment – Fourier Transform Spectrometer (ACE-FTS) satellite instruments to examine the influence of stratosphere-troposphere exchange (STE) on the abundance of upper tropospheric ozone. We characterize the regional and seasonal variations in mixing in the UTLS in GEOS-Chem and assess its impact on upper tropospheric ozone, with a particular focus on quantifying the contribution of STE to the ozone budget in the subtropics and mid-latitudes of the northern hemisphere in summer.

2C07.5 ID:3533 15:15

The extratropical mixing layer - Observations (START-08) versus Lagrangian modeling (CLaMS)

Paul Konopka[1], *Laura L. Pan*[2], *Anne Kunz*[1], *Baerbel Vogel*[1]
[1] Forschungszentrum Juelich, Germany
[2] NCAR Boulder, USA

Contact: p.konopka@fz-juelich.de

The extratropical mixing layer is a chemical transition layer across the extratropical tropopause with partly tropospheric and partly stratospheric character. Lagrangian trajectory studies were successfully applied in the last decade to quantify the origin and pathways of air crossing this layer.

However, using this approach only the advective part of transport can be determined although mixing, the irreversible part of transport, strongly contributes to the observed tracer-tracer correlations. The frequently observed mixing lines in the CO-O3 correlations are well-known examples of mixing occurring in the vicinity of the tropopause. Using the CO/O3 observations during the START-08 campaign together with the Chemical Lagrangian Model of the Stratosphere (CLaMS) where mixing between the Lagrangian air parcels is driven by the horizontal and vertical deformations in the flow, we show how the observed mixing lines can be transformed from the tracer into the physical space and how such signatures can be attributed to real physical processes.

Using a new, alternative definition of the tropopause, based on the PV-gradient on isentropes, we study the morphology of the mixing layer. In particular, we show how fresh mixing events which occurred on a synoptic time scale can be separated from those air masses which were mixed on a seasonal time scale. We discuss how both PV-gradient based analysis and CLaMS simulations help to find the freshly mixed regions within the mixing layer.

Weather and Society - Integrated Studies (Part 2) / La météo et la société - Études intégrées (Partie 2)

Room / Endroit (Capitale), Chair / Président (Jacques Descurieux), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C08.1 ID:3468 INVITED/INVITÉ 14:00

Integrated Research on Disaster Risk-Reducing Societies' Losses

Gordon Mcbean
University of Western Ontario
Contact: gmcbean@uwo.ca

Around the globe there is on average about one weather-climate related disaster per day. "Over the last two decades (1988-2007), 76% of all disaster events were hydrological, meteorological or climatological in nature; these accounted for 45% of the deaths and 79% of the economic losses caused by natural hazards" stated M. Wahlström, UN Assistant Secretary-General for Disaster Risk Reduction. She went on to say: "The real tragedy is that many of these deaths can be avoided." A new international research program Integrated Research on Disaster Risk: Addressing the challenge of natural and human-induced environmental hazards (IRDR) has been initiated as an integrated approach to research on disaster risk through: an international, multidisciplinary (natural, health, engineering and social sciences, including socio-economic analysis) collaborative research programme. Its Objectives are: 1) Characterization of hazards, vulnerability and risk; 2) Effective decision making in complex and changing risk contexts; and 3) Reducing risk and curbing losses through knowledge-based actions. A key challenge is building the natural-social sciences linkages to make this program a success and met the challenge stated by Wahlström. This paper will discuss the approaches being taken.

2C08.2 ID:4098 14:30

Disseminating Warning Information during a Tornado Outbreak: The Broadcast Perspective

Christopher Scott , *Martin Belanger* , *Patrick Cool*
Pelmorex Media, The Weather Network
Contact: cscott@pelmorex.com

The August 20th, 2009 tornado outbreak in Southern Ontario presented a significant challenge for broadcasters. As numerous tornadoes were sighted in populous regions including the Greater Toronto Area, broadcasters were inundated with information. The accurate and timely dissemination of Environment Canada watches and warnings was critical to informing the public of the tornado threat. Additionally, an unprecedented number of viewer photos, video and storm reports aided broadcasters in communicating the severity of the situation. Synthesizing this vast amount of information in a short period of time was a substantial challenge during the event as it is for all short-fuse warning situations.

This presentation will review the communication successes during the afternoon and evening of August 20th, in addition to making recommendations on improving communication during the next urban severe weather outbreak in Canada.

2C08.3 ID:3747 14:45

Moving warning systems from hazard to consequence: Practical considerations from road safety and lightning risk research

Brian Mills [1], *Jean Andrey* [2]
[1] Adaptation & Impacts Research, Climate Research Division, Environment Canada
[2] Dept. of Geography & Environmental Management, University of Waterloo

Contact: Brian.Mills@ec.gc.ca

Warning messages are the principal means through which National Meteorological and Hydrological Services (NMHSs) attempt to alert the public of severe weather threats to their safety and well-being. The efficacy of warnings is under inspection and question in terms of the ability to influence behaviour and other actions intended to reduce risk and protect property. A general and intuitively appealing response to this concern among warning system designers in Europe, and more recently in North America, has been to emphasize the impacts and consequences that accompany particular physical hazards. Drawing upon recent research to assess weather-related motor vehicle collision injury risks and lightning-related injuries and damages, the authors will examine several issues associated with developing a consequence-driven system including the accommodation of threshold variability. The integration of presently very disparate and incomplete efforts to monitor, track, and archive the impacts and consequences of—and responses to—weather-related hazards is viewed as a manageable short-term goal that would facilitate more formal evaluations of warning effectiveness.

2C08.4 ID:3569 15:00

Hazardous Weather Warning Success: Could it have little to do with the Forecast?

Jacques Descurieux
Environment Canada/Meteorological Service of Canada
Contact: jacques.descurieux@ec.gc.ca

Hazardous weather warnings are a means to an end. The end is the safety and the security of the population, the protection of property and the continuity of economic activity. Risk communication and perception studies analysing the response to terrorism and pandemics as pending risks indicate that cognitive and social factors may have a central if not primordial role in the adoption of preventative behaviour by an audience. Could this be also the case for hazardous weather? A qualitative comparative analysis (QCA) of several hazardous weather events suggest that warning success may be the result of warning content, timeliness and communication channels and not just of warning accuracy relative to event occurrence.

2C08.5 ID:3508 15:15

Weather Salience: A Key to the Value of Weather in Decision making

Rebecca Wagner
Environment Canada
Contact: rebecca.wagner@ec.gc.ca

In recent research by Allan E. Stewart, psychologist at the University of Georgia and others, there is evidence to support that understanding individuals

psychological attachment to weather can help understand their responses before extreme events. This becomes extremely important as meteorological services around the world attempt to make their weather warnings more relevant to those they are trying to protect. The concept of weather saliency revolves around a understanding of an individuals orientation, perceptions and attitudes towards weather and the value or importance the individual places on it. The theory of being able to quantify weather salience could be instrumental in increasing the utility of weather and climate products. A brief overview of the August 20th tornado outbreak in Ontario will be used to illustrate the principles related to the value placed on weather information and subsequent decision making.

General Atmospheric Sciences (Part 1) / Séance générale sur les sciences atmosphériques (Partie 1)

Room / Endroit (Panorama), Chair / Président (John M. Hanesiak), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C09.1 ID:3542 **14:00**

Planetary and synoptic analysis of freezing rain events in Montreal, Quebec

Gina Ressler , *Eyad Atallah* , *John Gyakum*
McGill University
Contact: gina.ressler@mail.mcgill.ca

Freezing rain is a major environmental hazard that affects many parts of Canada; however, it is especially prevalent along the St. Lawrence River Valley in Quebec. For large cities such as Montreal, severe events can have a devastating effect on people, property, and commerce. A tragic reminder is the 1998 Ice Storm, where between 80-100 mm of freezing rain fell in the Montreal area. To date, much of the research in the area of freezing rain has focused on analyzing the climatology, conducting individual case studies, or using statistical models to improve prediction. Few studies have conducted a thorough synoptic analysis of freezing rain events, fewer still in Quebec. Therefore, the goal of this project is to characterize the relevant synoptic-scale features of a Montreal freezing rain event, in hopes to better understand event causation, duration, and severity. Environment Canada hourly surface observations at Montreal, Quebec (YUL) for the period 1979-2008 are utilized to construct a complete list of freezing rain occurrences. 163 synoptically independent events are defined, and 46 of them are categorized as severe. Severe events are defined as having 6 or more hours of freezing rain observations per event. The North American Regional Reanalysis

(NARR) dataset is used to analyse the 500hPa height and absolute vorticity fields for each severe event. Based on the location of the 500hPa trough axis over North America, the events are partitioned into three synoptic types: western, central, and eastern cases. Composite dynamical structures are then presented for all three types, and a comparison of average duration and severity is made. Environment Canada 6-hourly precipitation data are also used to compare the average precipitation accumulation and intensity for all three types. Results indicate that, in general, western trough cases are longer lived, but eastern trough cases produce more intense precipitation.

2C09.2 ID:4046 14:15

Urban Dry Islands and Potential Impacts on Convective Environments and Drought

G.s. Strong [1], *Daniel Brown* [1], *C.d. Smith* [2]
(Presented by *Geoff Strong*)
[1] Earth & Atmospheric Sciences, University of Alberta
[2] Environment Canada
Contact: geoff.strong@shaw.ca

While conducting mobile surface transects during the 2008 UNSTABLE thunderstorm field project, an ‘urban dry island’ was detected over small central Alberta towns such as Wetaskiwin (pop. 12,000) and Ponoka (pop. 6,500). The dry island was estimated to be close to 1 g kg-1 mixing ratio; that is, measured average mixing ratios within towns were 1 g kg-1 lower than that measured while driving between agricultural crops on either side of roadways. The average ‘heat island’ effect was 0.5 °C or less within these small urban centres. This prompted an investigation of the urban dry island over larger cities such as Edmonton (pop. 780,000).

Mobile transects were subsequently carried out across Edmonton in E-W, NE-SW, and SE-NW directions on 15 days during mid-summer of 2009. Edmonton’s urban heat island, after eliminating diurnal effects, averaged between 2 and 3.5 °C, depending on cloud conditions. This corresponded well with earlier estimates by Strong (2005) using climatological data from Edmonton Municipal and International Airports. The urban dry island varied from 1 g kg-1 under cloudy conditions to an unexpectedly high 3 g kg-1.

The impact of these horizontal gradients of temperature and moisture across large urban areas such as Edmonton are contemplated in terms of their diurnal influence on daily convective environments, and their seasonal effect on the initiation and cessation of drought in the context of the Drought Research Initiative (DRI).

2C09.3 ID:3799 14:30

The development of a warm core cyclone along the Beaufort coast and its

role in the September 1999 Tuktoyaktuk storm surge event

David Small , *Eyad Atallah* , *John Gyakum*
McGill University Department of Atmospheric and Oceanic Sciences
Contact: david.small2@mail.mcgill.ca

The coastal community of Tuktoyaktuk on the Beaufort Coast of the Northwest Territories often experiences coastal erosion damage during storm surge events that occur in the late summer when the winter sea ice coverage gives way to large areas of open water. Scientific and anecdotal evidence suggest that the storm surge event of September 1999 was particularly damaging. Persistently high northwesterly winds produced coastal erosion damage and saltwater intrusion, poisoning ground water supplies and killing vegetation across the Mackenzie River Delta. This observational study presents a detailed meteorological investigation of the atmospheric conditions that helped produce such a devastating event. The results indicate that in the hours preceding the onset of strong northwesterly winds, a deep cyclone formed in the lee of the Rocky Mountains to the south and west of Tuktoyaktuk. After the cyclone rapidly moved to the east, a secondary development formed along the coast north and west of Tuktoyaktuk. This secondary development provided conditions favorable for the intense northwesterly winds that produced the storm surge damage. The secondary coastal development is notable because of the development process as well as the strength of the winds. Satellite images suggest the presence of a small, comma-shaped cloud reminiscent of a polar low near Tuktoyaktuk around the time when the wind speed increased. A detailed meteorological analysis of this small, short-lived event demonstrates that the storm exhibits a shallow, warm core structure that is similar to many polar lows reported in other areas of the world. An examination of the isentropic potential vorticity during the event strongly suggests that diabatic heating is the primary forcing of the vertical motions that enhanced the development of observed vortex. The results suggest that a rare Beaufort Coast polar low likely contributed to the severity of the wind event.

2C09.4 ID:3901 **14:45**

The impact of the St. Lawrence Valley on the precipitation distribution of Hurricanes Katrina, Rita (2005), and Ike (2008)

Eyad Atallah , *Shawn Milrad* , *John Gyakum*
McGill University
Contact: eyad.atallah@mcgill.ca

The Atlantic Basin hurricane season of 2005 was extraordinary considering the fact that there were twenty-seven named tropical cyclones. Of those twenty-seven events, two storms (Katrina and Rita) directly impacted the St. Lawrence Valley (SLV) as they underwent extratropical transition (ET), resulting in significant flooding across many area located near the SLV. In fact over 50% of the seasonal rainfall in the fall of 2005 in the SLV can be directly attributed to the aforementioned storms. These cases are particularly interesting because

precipitation amounts in close proximity of the SLV were generally 25-50% greater than precipitation amounts to the north and south of the SLV. A similar, more recent event occurred in 2008 during the ET of Hurricane Ike. Consequently, this study will try to assess the dynamic and thermodynamic factors which account for the increased precipitation values immediately along the valley. Recent work by Carrera et al. (2009) established the preference of along-SLV winds for numerous SLV stations. In the case of synoptic-scale low pressure systems approaching the region from the southwest, the surface wind in the Valley is often from the northeast, as a result of pressure driven channeling. This pressure driven channeling results in enhanced frontogenesis along the SLV, as relatively cool-dry air is advected by the northeasterlies into along-SLV locations. Preliminary results indicate that during the ET's of Katrina, Rita, and Ike, the enhanced forcing for ascent from frontogenesis was fairly shallow in nature as it is driven by a shallow topographical feature. However, while the forcing was relatively shallow, the thermodynamic structure of the atmosphere (moist neutral to convectively unstable) facilitated enhanced vertical ascent throughout a deep layer in the troposphere. Consequently, the resulting precipitation distributions were strongly impacted, with upwards of 50% more rain falling in the immediate vicinity of the SLV.

2C09.5 ID:3479 15:00

Boundary Layer Wind Profiles of Hurricanes Landfalling in Florida with NEXRAD Data

Julie Le Fevre , *Pavlos Kolias* , *John Gyakum* , *Eyad Atallah* , *Scott Giangrande*
McGill University, Atmospheric and Oceanic Sciences Department
Contact: julie.lefevrebouge@mail.mcgill.ca

Hurricanes are one of the major natural hazards and their intensity is yet not well understood and predicted by models and humans. Damage is caused by devastating precipitation and boundary layer winds. Those winds that take place in the layer from zero to two kilometers above the ground (boundary layer) are not well known and captured by models which results in limiting the forecasting efficiency. The main reason is the lack of observations in the boundary layer. The new technique we applied allowed us to construct wind profiles from NEXRAD data. Considering a ring of velocity data close enough to the radar, we can assume the wind is constant over the area defined by the ring. This allows us to retrieve the wind magnitude and direction over the radar thanks to the velocity azimuth display (VAD) method. Using different elevations we consider rings at different heights and thus construct a profile of the boundary layer winds of landfalling hurricanes. The profiles of wind magnitude and direction have been computed for Hurricane Wilma (2005) and Katrina (2005) on the Miami radar and for Hurricane Katrina on the Key West radar. All the profiles seem to be fairly correct and the value the closest to the ground matches well with surface observations. A few of the profiles of Wilma could not be obtained due to aliasing problems. Some aliasing detection and correction methods have thus been tried. The profiles have been compared to profiles obtained from the North American

Regional Reanalysis (NARR) at the radar position. The results show that the wind direction profiles from the radars can match quite well with the NARR profiles, the wind magnitude is always strongly underestimated by the NARR; this emphasizes the importance of the information provided by the radar profiles.

2C09.6 ID:3933 **15:15**

The Application of Total Lightning Detection for Severe Storm Prediction

Charlie (chonglin) Liu , *Stan Heckman*
AWS WeatherBug
Contact: janderson@weatherbug.com

In-cloud lightning generally occurs ten to thirty minutes before cloud-to-ground flashes, providing early indicators of development of weather events such as severe thunderstorms and tornados. Thus, the detection of both in-cloud (IC) and cloud-to-ground (CG) strokes, or total lightning, enables improvements in the lead times for severe weather prediction.

This discussion will provide insight into the development of a lightning network, WeatherBug Total Lightning Network,™ created specifically for the detection of both IC and CG lightning strokes. WeatherBug Total Lightning Network (WTLN) covers the mainland US, Alaska and Hawaii islands with a high density of sensors, and covers Canada, Mexico, and the Caribbean with a low density network.

Using the lightning data from WTLN, a real-time lightning cell tracking program has been developed. The properties of lightning cells preceding a number of severe storms in the Mid-West and in the South East of US have been studied, and certain patterns in the lightning cells have been identified.

The time evolution of the lightning flash rate and the time evolution of the IC/CG ratio of individual cells are used to identify thunderstorms likely to produce damaging hail, high wind, or tornadoes minutes before the hail, wind, or tornadoes occur. Studies have shown that early detections of the sudden rise of the rate of IC discharges and subsequent high flash rate of CGs can serve as an indicator for severe storm conditions. The results of several storm studies will be presented.

Low-frequency variability and predictability (Part 1) / Variabilité et prévisibilité à basse fréquence (Partie 1)

Room / Endroit (Pinnacle), Chair / Président (Hai Lin), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C10.1 ID:3297 INVITED/INVITÉ 14:00

MJO and convectively coupled waves in a coarse GCM with a simple multicloud parametrization

Boualem Khouider [1], *Amik St-Cyr* [2], *Andrew Majda* [3], *Joseph Tribbia* [2]
[1] University of Victoria
[2] NCAR
[3] Courante Institute, NYU
Contact: khouider@uvic.ca

In this paper we use the next generation NCAR GCM—HOMME, as a dry dynamical core coupled to the multicloud parametrization of Khouider and Majda. The coupling is performed based on the vertical structure functions of Kasahara and Puri to represent the three cloud types, congestus, deep, and stratiform, that characterize organized tropical convection,.

We present three numerical simulations with two different moisture profiles and stratiform fractions. The first experiment uses a strong moisture background and a small stratiform fraction and provides an MJO example. It results in an intra-seasonal oscillation of zonal wavenumber two, moving eastward at a constant speed of roughly 5 m s^{-1}. The second uses a weaker moisture background and a large stratiform fraction and yields convectively coupled Rossby, Kelvin and two-day waves, embedded in and interacting with each other while the last one combines the small stratiform fraction and the weak moisture background to yield a planetary scale (wavenumber one) second baroclinic Kelvin wave, at odds with observations. However, both the intra-seasonal oscillation and the synoptic scale waves have phase speeds and zonal and vertical structures that are in excellent agreement with observations, demonstrating the importance of both moisture and stratiform anvils for organized tropical convection. The MJO in particular has strong westerly winds trailing easterlies at the surface and has a baroclinic vertical structure while the off-equatorial flow is characterized by a quadrupole vortex. The active phase of the MJO has spikes of convection that are either standing or move in either direction, embedded in the large scale propagating envelope, featuring the zero group velocity that characterizes the MJO. Congestus heating dominates the inactive phase on the off-equatorial flanks and as such it helps precondition and restore the moisture level after the passage of a strong MJO event.

2C10.2 ID:3611 14:30

Nonlinear Seasonal Modulations of the tropical MJO Cycle

Johannes Jenkner [1], *William W. Hsieh* [1], *Alex J. Cannon* [2]
[1] Department of Earth and Ocean Sciences, University of British Columbia
[2] Meteorological Service of Canada

Contact: jjenkner@eos.ubc.ca

The Madden–Julian Oscillation (MJO) is the dominant pattern of intraseasonal variability in the tropical atmosphere. Traditionally, linear principal components (LPCs) are derived in tropical atmospheric fields to identify the dynamical signal of the MJO. The restriction to a leading subset of the LPCs provides a reduction of dimensionality and ideally discards all computational modes without a physical background.

Here, an alternative MJO definition is presented with a nonlinear principal component analysis based on a neural network with a circular bottleneck node. The leading nonlinear principal component (NLPC) explains maximum variability along a curved path in the feature space and is used to describe the MJO cycle by a single mode. The bandpass–filtered input data encompass 30 years with zonal wind on 850 hPa and 200 hPa plus outgoing longwave radiation (OLR). The NLPC is conditioned on an active MJO and is computed both for the pooled dataset and for the dataset stratified into seasons.

The solution for all data depicts a circular mode within the leading two LPCs and marginally projects onto the higher–order LPCs. The solution for individual seasons shows additional variability which mainly arises from a stronger contribution of the higher–order LPCs. In reference to the annual solution, the difference of resolved variability accounts for approximately 5% in equinoctial seasons and for approximately 10% in solstitial seasons. Around the equinox, the MJO cycle shifts only slightly. Westerlies are somewhat more pronounced over the Indian (eastern Pacific) Ocean during boreal spring (fall). Around the solstice, the amplitude of the MJO signal is altered on a broader scale. In particular, the third LPC is evoked at that time of the year. This mode is characterized by OLR anomalies over the Maritime Continent and baroclinic wind modulations which peak in phase over the Indian and eastern Pacific Oceans. The phase lag is such that convective activity oscillations over the Maritime Continent as well as wind oscillations over the Indian Ocean appear to be enhanced (suppressed) during boreal winter (summer).

Overall, the presented approach provides a clearly arranged mapping of the MJO cycle and sheds some new light on the seasonal variations of the MJO.

2C10.3 ID:3724 14:45

Expressions of the Madden-Julian Oscillation in the Coastal Ocean: The Gulf of Carpentaria

Eric Oliver , *Keith Thompson*
Department of Oceanography, Dalhousie University
Contact: eric.oliver@dal.ca

The Madden-Julian Oscillation (MJO) is a significant contributing factor to intraseasonal variability in both the tropical and extratropical oceans. It is evident as regional standing modes in coastal waters and as propagating modes along the major coastal and equatorial waveguides. Sea level and circulation variations in the Gulf of Carpentaria (northern Australia) and the coastal regions of the northeastern Indian Ocean and eastern Pacific are related to the MJO [Oliver and Thompson, 2010, JGR, 115, C01003]. In this presentation, we focus on the the Gulf of Carpentaria. Using a three-dimensional, nonlinear, barotropic, numerical model validated with local tide gauge data we show that sea level variations in this region are driven by surface wind stress. This wind stress is, in turn, highly dependent on the MJO and is also seasonally modulated. The response of both sea level and circulation to MJO forcing is quantified. The model is next used to remove the local wind effect from the tide gauge data resulting in a low frequency residual signal which is interpreted in terms of larger scale modes of variability of the adjacent shelf seas and deep ocean. Implications for coastal ocean forecasting in this region are discussed.

2C10.4 ID:3903 15:00

The relationship between intra-seasonal variations of sea level pressure and the Madden-Julian Oscillation

Yang Zhou [1], *Youyu Lu* [2], *Jing Jiang* [1]
[1] Nanjing University
[2] Bedford Institute of Oceanography
Contact: LuY@mar.dfo-mpo.gc.ca

The linear relationship between intra-seasonal variations of sea level pressure (SLP) and Madden-Julian Oscillation (MJO) in the boreal winters during 1979-2008 is examined using various statistical methods. At low latitudes between 30°S and 30°N, the SLP variations are clearly linked to the MJO. In extratropical regions, in different MJO phases the averaged SLP anomalies are “significantly different from zero”, but there is no significant correlation between the MJO and the SLP variations at the lags of 0-3 pentads; and the regression of the SLP variations to the MJO indices can explain only less than 5% of the variance of the SLP at intra-seasonal time scale.

2C10.5 ID:3471 15:15

Impact of the Madden-Julian Oscillation on wintertime precipitation in Canada

Hai Lin [1], *Gilbert Brunet* [1], *Ruping Mo* [2]
[1] Meteorological Research Division, Environment Canada
[2] Pacific Storm Prediction Centre, Environment Canada
Contact: hai.lin@ec.gc.ca

Based on the adjusted daily total precipitation data at Canadian stations and the Climate Prediction Center Merged Analysis of Precipitation (CMAP) data during the most recent 30 Northern Hemisphere winters, the connection between the tropical convection of the Madden-Julian Oscillation (MJO) and the intraseasonal

variability of precipitation in Canada is investigated. The dominant convection patterns associated with the MJO are represented by the two leading modes of the empirical orthogonal function (EOF) analysis that is applied to the pentad OLR in the equatorial Indian Ocean and western Pacific. The first EOF mode is characterized by a single convection center near the maritime continent, whereas the second EOF has an east-west dipole structure with enhanced precipitation over the Indian Ocean and reduced convective activity over the tropical western Pacific. Lagged regression analysis reveals significant precipitation anomalies in Canada associated with the second OLR EOF pattern. Above normal precipitation starts to occur in the west coast of Canada one pentad after a positive EOF2 phase. In the next two pentads, positive precipitation anomalies extend to a large area of south Canada. At the same time, the northeast region experiences reduced precipitation. An analysis of the evolution of the Northern Hemisphere circulation anomalies indicates that the Canadian precipitation anomaly is a result of a Rossby wave train associated with the tropical dipole convection anomaly of the MJO. A linearized global primitive equation model is utilized to assess the cause of the intraseasonal variability in the Northern Hemisphere extratropics and its influence on North American weather associated with the tropical heating of the MJO.

Remote Sensing of the Oceans / Téléobservation des océans

Room / Endroit (Bytowne), Chair / Président (Howard R. Edel), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C11.1 ID:4083 INVITED/INVITÉ 14:00

Remote Sensing of Canada's Oceans – An Increasingly Important Tool for Ocean Observing by Fisheries and Oceans Canada

Helen Joseph
Fisheries and Oceans Canada
Contact: Helen.Joseph@dfo-mpo.gc.ca

Canada's ocean estate covers a surface area of approximately 7 million square kilometres. Conventional in-situ monitoring of this ocean area would be difficult and costly, especially in the North. There is enormous potential for the use of satellite data and Fisheries and Oceans Canada is actively exploring the use of this data, combined with conventional ocean monitoring, as a means to monitor Canada's oceans and in the department's daily operations. Over the past five years and largely through the support provided by the Canadian Space Agency's Government Related Initiatives Program (GRIP), DFO Science has steadily increased its use of satellite data. This presentation will highlight current remote sensing activities where data have been used to quantify and track the ocean's physical, chemical and biological conditions. Products of remote sensing may be used for provision of advice on habitat and population studies; ecosystem status and trends; emergency preparedness; operational oceanography and provision of real-time ocean weather forecasting; and improved climate change scenarios. These services are critical to generate forecasts for the management and policy activities of Canada's oceans and waterways.

2C11.2 ID:3733 14:30

Validation of Space-based Automatic Identification System (AIS) data using RADARSAT-2 images.

Paris W. Vachon , *Nicholas Sandirasegaram* , *Ryan English*
(Presented by *Ryan English*)
Defence R&D Canada – Ottawa
Contact: nicholas.sandirasegaram@drdc-rddc.gc.ca

Space-based Automatic Identification System (AIS) data can be routinely used for ocean surveillance applications. Ensuring the validity of the received AIS messages is critical to these applications. We have used RADARSAT-2 images to validate COM DEV's Nano-satellite Tracking of Ships (NTS) space-based AIS system. There were concurrent acquisitions of space-based AIS data and RADARSAT-2 ScanSAR Narrow B mode imagery (HH + HV) off the northwest coast of Norway, and the west coast of Iceland on several dates in 2008 and 2009. We selected regions away from the seashore and floating ice, and validated the received AIS messages. Ships were detected in the RADARSAT-2 imagery using several different ship detection engines and were correlated with the space-based AIS data. There were a total of 174 ships identified in the selected region. Of these, 71% were detected by NTS AIS. The ship detection engines were able to detect up to 90% of the ships present, with a few false alarms.

2C11.3 ID:3740 14:45

A SAR-Derived Wind Speed Model for C-band Cross-Polarized Ocean Backscatter

Paris W. Vachon , *John Wolfe*
Defence R&D Canada – Ottawa
Contact: nicholas.sandirasegaram@drdc-rddc.gc.ca

As part of a GRIP-sponsored project called RADARSAT-2 Mode Selection for Maritime Surveillance (R2MS2), lead by the Canadian Ice Service (CIS) and carried out in partnership with DRDC Ottawa, research into SAR-derived winds is ongoing by exploiting a significant database of RADARSAT-2 Fine Quad (FQ) Mode data acquired over operational buoys off both the East and West coasts of Canada. Data acquisition and analysis began in October, 2008. The FQ data

provides simultaneously-acquired co-polarization (i.e., HH and VV) and cross-polarization (i.e., HV and VH) observations. Existing co-polarization SAR-derived wind speed models depend on both the incidence angle and the sometimes elusive and inaccurate relative wind direction. The objective is to show the relationship between cross-polarized ocean backscatter and wind speed (a simple power-law), incidence angle (essentially independent), and relative wind direction (essentially independent). A simple model for deriving wind speed from cross-polarized SAR ocean backscatter is provided.

2C11.4 ID:3662 15:00

Floaters and Sinkers: Remote Sensing Reveals the Fate and Impact of Mesoscale Ocean Eddies

W.r. Crawford
Fisheries and Oceans Canada
Contact: bill.crawford@dfo-mpo.gc.ca

I class mesoscale eddies of eastern boundary currents as floaters or sinkers based on their origin and the nature of ocean gyres into which they propagate. Haida and Sitka Eddies of the northeast Pacific form in warm, fresh water and float over the dense water of the Alaskan Gyre. Meddies of the Atlantic Ocean are sinkers because they form in dense waters and move into a gyre with low-density surface water. These features account for the relatively long persistence time of Haida and Sitka Eddies in maps of sea level and chlorophyll provided by satellites, and also for the invisibility of Meddies in these images. I will present satellite images to show how these two classes of eddies are extremes of mesoscale eddies, and how floaters can stimulate primary productivity by injecting nutrients up into surface waters, and floaters can sequester organ carbon into the deep ocean.

2C11.5 ID:3587 15:15

Remote Sensing of SPM Concentrations in the Upper Bay of Fundy

Gary Bugden , *Gordana Lazin* , *Tim Milligan* , *Ed Horne*
Fisheries and Oceans Canada
Contact: Gary.Bugden@mar.dfo-mpo.gc.ca

Throughout history, anthropogenic modifications have caused extensive changes in the hydrological and geological characteristics of tidal rivers in many parts of the world. One local example of tidal river modification is the causeway constructed in the late 1960's in the Petitcodiac River near Moncton, New Brunswick. This construction resulted in rapid, readily apparent, sediment accumulation on the immediate downstream side of the barrier. However, recent analysis indicates that the consequences of causeway construction extend nearly 34 km downstream. Because of these problems and the failure of the causeway to allow adequate passage for migratory fish it is slated for extensive modification in the near future. Recent advances in remote sensing techniques allow ocean

colour satellite imagery to be used to estimate the distribution of suspended particulate matter (SPM) in the coastal zone. A series of satellite images is used to develop baseline data on the distribution of SPM at the mouth of the Petitcodiac River before causeway modifications and, incidentally, in the region of recent tidal power generation experiments in Minas Basin.

Crust to Core: Structure observations & models (Part 1) / De la croûte au noyau : observations de la structure et modèles (Partie 1)

Room / Endroit (York), Chair / Président (Catrina Alexandrakis and Jeff Gu), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C12.1 ID:3595 **14:00**

3D P-wave velocity structure beneath the Abitibi-Grenville region, eastern Canadian Shield

<u>Mélanie Villemaire</u>
GEOTOP UQAM-McGill
Contact: mvillemaire@hotmail.com

Seismic studies of the upper mantle of the Canadian Shield have indicated a low-velocity anomaly within the cratonic lithosphere near the Ontario-Quebec border, in the Abitibi-Grenville region. The lack of seismograph station coverage to the east and south-east of the studied area previously prevented definition of the 3D geometry of this anomaly. Adding new stations from the province of Quebec and from the United States allows us to carry out new studies of the P-wave velocity structure of the lithosphere surrounding that low-velocity anomaly, in order to better understand the complexity of the region and the interaction of the lithosphere with possible thermal anomalies in the underlying mantle. About 200 events have been analysed during this study. To do so, we used teleseismic P wave arrivals recorded at 45 stations deployed across the region, 19 situated in the province of Quebec, 18 in Ontario and 8 spread across the north-eastern USA. The relative arrival times of teleseismic P waves across the array were measured using the cross-correlation method of VanDecar & Crosson (1990). Maps of relative arrival time residuals across the array for earthquakes coming from different back-azimuths have been calculated in order to examine systematic patterns of travel-time anomalies resulting from mantle heterogeneity. We then invert the travel time data to estimate the 3D P-wave velocity structure beneath the region, using the least-squares tomographic inversion code of VanDecar (1991). Regularization and resolution tests were carried out, and we present depth slices and cross-sections that constrain the geometry of the low-velocity anomaly and surrounding upper mantle structures.

2C12.2 ID:3617 INVITED/INVITÉ 14:15

Structural variations across northern Hudson Bay from Rayleigh wave phase velocities

Fiona Darbyshire [1], *Ian Bastow* [2], *Mike Kendall* [2], *George Helffrich* [2], *James Wookey* [2], *David Thompson* [2], *David Snyder* [3], *David Eaton* [4]
[1] GEOTOP UQÀM-McGill
[2] University of Bristol, UK
[3] Geological Survey of Canada
[4] University of Calgary
Contact: darbyshire.fiona_ann@uqam.ca

The upper mantle structure of Hudson Bay has been the focus of intense study in recent years. The region is tectonically complex, comprising the Paleoproterozoic Trans-Hudson Orogen surrounded by Archean cratons. Through the Hudson Bay Lithospheric Experiment (HuBLE), a network of broadband seismographs has been installed around the perimeter of the Bay. The network is particularly dense across the northern limits of the Bay, and this northern deployment permits the use of array analysis techniques to study structural variations in the upper mantle across the region.

We use data from Rayleigh waves that propagate across the array to study phase velocity variations in the lowermost crust and upper mantle beneath northern Hudson Bay. The incoming wavefield is simulated as the superposition of two plane waves. The inversion scheme solves simultaneously for wavefield characteristics and phase velocity variations at a range of periods from 20 to 200 seconds, using finite-frequency sensitivity kernels.

The initial step in the analysis is the estimation of a 1D dispersion curve that represents the average structure beneath the region as a whole. Modelling for shear wave velocity structure reveals a high-velocity ‘lid’ in the upper mantle to ~200km depth, interpreted as the seismological expression of the subcontinental lithosphere. The 1D dispersion curve is used as a starting model for the inversion to calculate isotropic phase velocity maps for the region. The resulting maps show variations in Rayleigh wave phase velocity of up to 4% around the average for each period, with the largest range of variations at short and intermediate periods (upper to mid lithosphere). The phase velocity maps and models of shear-wave velocity structure will provide information on regional structural variations between the Archean cratons in the north and west of the study region and the Proterozoic foldbelts in the south and east.

2C12.3 ID:3472 INVITED/INVITÉ 14:45

S-Receiver Functions and the Lithosphere-Asthenosphere Boundary (LAB)

Rainer Kind
GFZ Potsdam
Contact: kind@gfz-potsdam.de

For seismologists the LAB is a very exotic boundary. It was not defined by seismic means. There is broad agreement that the asthenosphere can be imaged as low velocity zone by surface waves. The boundary between asthenosphere and lithosphere, however, cannot be imaged laterally and vertically with this technique with the sufficient resolution. This is not seen as a problem by those, who define the LAB by an isotherm, since no sharp transition is expected in this case. Wide angle body wave data, from natural source or controlled source experiments have a higher resolution, but no sufficiently dense observations are available. Seismic techniques which use converted waves are now far enough developed to be successful in observing the LAB with high resolution and density. The principle of this technique is that a strong mother phase (e.g. P or S) produces at the LAB beneath a seismic station a small converted phase, which indicates the properties of the LAB. Due to the freely available data from many seismic stations it is now possible to obtain maps of the LAB topography with so far unprecedented resolution. The receiver function technique has the potential to gain the same significance for the lower lithosphere like steep angle seismics for the upper lithosphere. We are discussing global observations of the LAB in tectonically different region obtained from mainly S-receiver functions and compare it with results from other geophysical observational techniques and also with the multiplicity of geodynamic LAB definitions.

2C12.4 ID:3450 15:15

The cratonic mantle keel beneath Laurentia: New evidence for assembly by slab accretion

David Eaton [1], *Meghan Miller* [2], *Fiona Darbyshire* [3]
[1] University of Calgary
[2] University of Southern California
[3] University of Quebec at Montreal
Contact: eatond@ucalgary.ca

Laurentia, the North American protocontinent, formed ca. 1.8 Ga by collisional assembly of several Archean cratons. The lithospheric mantle (a.k.a. tectosphere) beneath Laurentia appears as a prominent high-velocity anomaly in numerous global and regional tomographic reconstructions; it has long been recognized as a classic example of a refractory cratonic mantle keel in which the density increase related to low temperature (estimated to be 400K less han ambient conditions) is approximately offset by intrinsic buoyancy associated with strongly depleted composition. Key unresolved questions about such mantle keels concern the process(es) of formation, secular evolution and degree of present-day coupling to flow in the deeper mantle. The Hudson Bay Lithospheric Experiment (HuBLE) is an international initiative to investigate the lithospheric architecture of Laurentia using geophysical observatories deployed around the periphery of Hudson Bay. This paper focuses on the regional tectonic framework and reports some of the initial results from HuBLE, based on analysis of Rayleigh-wave dispersion and application of S-Receiver Functions. Our analysis confirms the presence of thick (up to _ 260 km), high-velocity lithosphere and suggests that the lithosphere-asthenosphere boundary (LAB) is relatively sharp. No significant differences are observed between regions of Archean and Proterozoic age. S-receiver functions indicate that shallow dipping mid-lithospheric discontinuities are common within this arc-acretionary tectonic setting, providing support for the formation of cratonic lithosphere by accretion of subducted slabs.

Stratospheric Processes and their Role in Climate (Part 4) / Les processus stratosphériques et leur incidence sur le climat (Partie 4)

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Saroja M. Polavarapu), Date (02/06/2010), Time / Heure (14:00 - 15:30)

2C14.1 ID:3448 **14:00**

Eight years of mesospheric and stratospheric temperature observations at Resolute (75º N) in the context of solar flux and quasi-biennial variations

Gordon Shepherd , *Young-Min Cho* , *Marianna Shepherd*
CRESS - York University
Contact: gordon@yorku.ca

A Spectral Airglow Temperature Imager (SATI) has been operated at Resolute (75º N) from 2001 to 2009, providing mesospheric temperatures from the OH Meinel (6,2) band airglow from a nominal altitude of 87 km. The year-to-year temperature variability, which included a full maximum to minimum of the solar cycle was investigated and compared with the temperatures at 22.5 km obtained from radiosonde measurements taken from the Resolute weather station. For both datasets, an anticorrelation with the quasi-biennial oscillation (QBO) was found in the sense that positive (eastward) zonal winds at the equator corresponded to negative temperature anomalies, and the reverse; a relationship that had earlier been recognized for the lower stratosphere. When the monthly

mesospheric temperatures were plotted versus solar flux, separately for the two phases of the QBO, a good correlation was found for the westerly phase of the QBO and a low correlation for the easterly phase, as has been recognized for the lower stratosphere. Finally, when the upper mesospheric monthly temperature anomalies were plotted versus those for the lower stratosphere, a high correlation was found for the westerly phase of the QBO and a low correlation for the easterly phase. This is also a new finding for the upper mesosphere, and indicates either a coupling between the two regions or simply a common response to the same source, the solar flux whose influence appears to be modulated by the QBO.

2C14.2 ID:3592 14:15

The Upper Stratosphere/Lower Mesosphere (USLM) and Stratopause Evolution in Satellite Data and Advanced Data Assimilation Systems

Gloria Manney [1], *Saroja Polavarapu* [2], *Karl Hoppel* [3], *Michael Schwartz* [4], *Ken Minschwaner* [5], *Kirstin Krueger* [6], *Shuzhan Ren* [2], *William Daffer* [4]
[1] Jet Propulsion Laboratory & New Mexico Tech
[2] Environment Canada
[3] Naval Research Laboratory
[4] Jet Propulsion Laboratory
[5] New Mexico Tech
[6] IFM-GEOMAR
Contact: Gloria.L.Manney@jpl.nasa.gov

Variability of and changes in the USLM circulation play an important role in the climate of the entire atmosphere, and are sensitive to climate change. Microwave Limb Sounder (MLS), Sounding of the Atmosphere using Broadband Emission Radiometry (SABER), and Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS) data are used to characterize the structure and evolution of the stratopause region for the past five to eight years. Analyses include the breakdown and reformation of the stratopause during recent stratospheric sudden warmings, and interhemispheric comparisons of the seasonal evolution of the stratopause. The representation of the USLM in advanced assimilation systems, including the Canadian Middle Atmosphere Model Data Assimilation System analysis produced for the International Polar Year (IPY) and the Naval Research Laboratory's NOGAPS-ALPHA model assimilating MLS and SABER temperatures, is compared with results from the satellite datasets.

2C14.3 ID:3685 14:30

Ozone Data Assimilation with the CMAM-DAS

Stephen Beagley [1], *Yves Rochon* [2], *Shuzhan Ren* [3], *Yan Yang* [2], *Andreas Jonsson* [3], *Chris Mclinden* [2]
[1] York University
[2] Environment Canada

[3] University of Toronto
Contact: beagley@nimbus.yorku.ca

Recent work has enabled the incorporation of OSIRIS and MLS ozone observations into the Canadian Middle atmosphere model (CMAM) Data Assimilation system (DAS). Initial results from a CMAM-DAS cycle parallel to the International Polar Year (IPY) cycle and using ozone assimilation will be presented. This includes exploring the impact of the addition of these new data sources upon the IPY data products and a further assessment of the CMAM model's free-run chemistry capabilities for stratospheric simulations. Future plans will include utilization of SABER and/or MLS water and temperature to enhance the stratospheric ozone analysis product. Particular emphasis will be placed on the analysis of changes upon the polar simulation capabilities of the CMAM.

2C14.4 ID:3762 **14:45**

Stratospheric temperature and ozone assimilation with an ensemble Kalman filter in a chemistry-climate model

Thomas Milewski , *Michel Bourqui*
McGill University
Contact: thomas.milewski@mail.mcgill.ca

The potential of ensemble Kalman filtering is explored for chemistry-climate simulations in the stratosphere, in the context of a perfect-model, observation simulation system experiment. The model used is an intermediate-complexity general circulation model with a fast interactive ozone chemistry scheme, the IGCM-FASTOC. It is the first time that ensemble data assimilation is applied to a comprehensive chemistry-climate model in the stratosphere. The only data assimilated are simulated temperature or ozone retrievals with MIPAS error and coverage characteristics. The quality of the ensemble covariances, with proper localization, is investigated by looking at the improvement in the analysis of the different state variables. It is observed that, in this idealized context, substantial constraints can be imposed on dynamical variables when assimilating temperature data but also when assimilating no dynamical fields, only ozone retrievals. This brings forward the possibility of ensemble assimilation to help in the classical problem of improving stratospheric wind representation. Further research will also be discussed to extend the study to more general cases, such as the inclusion of model errors when lifting the perfect-model hypothesis, or going towards an ensemble Kalman smoother to assimilation asynchronous observations by including the time domain in the covariances.

2C14.5 ID:4019 **15:00**

Middle atmosphere response to the 11-year variability in solar irradiance and ionizing particle precipitation

Kirill Semeniuk [1], *Victor Fomichev* [1], *Stella Melo* [2]
[1] York University

[2] Canadian Space Agency/Environment Canada
Contact: stella.melo@asc-csa.gc.ca

Traditionally, only effects of varying solar irradiance are considered in model simulations of the middle atmosphere response to solar variability. However, satellite measurements have shown that aurora, solar proton events and galactic cosmic rays enhance the NOy production contributing to ozone loss in middle and high latitudes above 20 km. In this paper we use the Canadian Middle Atmospheric Model to conduct a comparative analysis of the effects of varying solar irradiance and varying ionizing particle precipitation in the 11-year solar cycle. The inclusion of ionizing particles in the model affects the evolution of the polar vortex and the Brewer-Dobson circulation, especially in the southern hemisphere. Through the modulation of the Brewer-Dobson circulation tropical temperatures are affected, leading to a change in the transport of water vapour through the tropical tropopause layer.

2C14.6 ID:4045 15:15

Tidal Structuring of the Middle Atmosphere

William Ward [1], *Jens Oberheide* [2], *Larisa Goncharenko* [3], *Cawses Global Tidal Campaign Team* [4]
[1] Dept of Physics, University of New Brunswick
[2] University of Wuppertal, Germany
[3] MIT Haystack Observatory
[4] Various Institutions
Contact: wward@unb.ca

Recently it has been realized that tidal components other than the well known migrating tides have significant amplitudes in the middle atmosphere. Analyses of satellite and radar observations during the CAWSES Global Tidal Campaign Project (a project under Theme 3 "Atmospheric Coupling Processes" of CAWSES (Climate and Weather of the Sun Earth System program, a SCOSTEP sponsored program)) have shown that the amplitudes of these non-migrating tides are large enough to supress the migrating tides completely at certain longitudes. These results confirm similar features seen in the extended Canadian Middle Atmosphere Model. Interference between these tidal modes result in stationary geographic variations in the local amplitudes of the diurnal, semi-diurnal and terdiurnal tides. This structuring affects the local temperature, wind and constituent variabilities. These structures vary seasonally and are the primary reason for the observed variability in tidal amplitudes observed by different ground stations. This dynamical structuring of the atmosphere is an interesting aspect of the coupling through tides between the troposphere where most of these tides are forced and the mesosphere where these tidal components attain large enough amplitudes to dominate the dynamics. In this talk the nature of this coupling will be outlined using results from the CAWSES Tidal Campaigns and the extended Canadian Middle Atmosphere Model.

Atmosphere, Ocean, and Climate Dynamics (Part 2) / Dynamiques de l'atmosphère, de l'océan et du climat (Partie 2)

Room / Endroit (Ballroom A), Chair / Président (Marek Stastna), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D01.1 ID:3860 INVITED/INVITÉ 16:00

Zonal structures in wind-driven ocean gyre models

David Straub [1], *Balu Nadiga* [2]
[1] McGill
[2] Los Alamos
Contact: david.straub@mcgill.ca

Recent observational and numerical studies have unmasked the presence of zonal jets in the midlatitude oceans. Here, three studies are presented in which jets appear as the result of large scale forcing in a closed basin beta plane. In the first, the jets are associated with a (linear) meridional cascade of energy in near-inertial modes. Energy input at high frequency and large spatial scales quickly develops large meridional wavenumbers, with this cascade being halted by nonlinear effects. The second study considers the barotropic double gyre problem, for which the quasigeostrophic approximation filters inertial oscillations. The jets appear only in long time averages and only in the weakly forced, weakly dissipated limit. This regime is also associated with a double cascade of energy, with a beta term allowing for a transfer of energy forward well beyond the Rhines scale the nonlinear cascade bringing energy back towards this scale. Finally, in a baroclinic version of this problem, a regime is discussed where the jets appear in instantaneous snapshots (i.e., are much stronger than in the barotropic problem). The energy cascades associated with this regime are also considered, as are effects of topography along the western boundary on the strength of the jets in the interior.

2D01.2 ID:3955 16:30

Eddy-driven and subtropically-influenced jet variability structures in the observed three-dimensional wind field

Camille Li [1], *Justin J. Wettstein* [2]
[1] Bjerknes Centre for Climate Research and University of Bergen
[2] Bjerknes Centre for Climate Research
Contact: camille@uib.no

The three-dimensional structure of extratropical tropospheric zonal wind variability in the ERA-40 reanalysis is investigated using a variety of horizontal, vertical and three-dimensional EOF-based analyses. The leading PCs of zonal wind and near-surface geopotential height are shown to be linked, but the correspondence is not one-to-one and the relationship is both height- and sector-dependent. The height-dependence has one of two characteristic shapes consistent with either eddy-driven or subtropically-influenced jet variability. The leading three-dimensional EOFs of the zonal wind field have a clearer relationship with eddy-driven or subtropically-influenced jet variability and explain more zonal wind variance than alternative indices. The relative importance of annular variability in the Northern Hemisphere is concentrated at low frequencies, suggesting different dynamics are important on different time scales and that much of the month-to-month variability occurs in sectors. Sector-based analyses in the Northern Hemisphere are also generally more statistically robust and dynamically intuitive than hemisphere-based analyses. The results suggest the generic co-existence of eddy-driven and subtropically-influenced jet variability, and that the relative dominance of one over the other is governed by the different jet configurations that exist in the various hemispheres and / or sectors: (1) North Atlantic variability is predominantly eddy-driven, (2) North Pacific variability is predominantly subtropically-influenced, and (3) Southern Hemisphere variability is predominantly eddy-driven, except in the South Pacific, where evidence of subtropically-influenced variability also exists.

2D01.3 ID:3989 16:45

On Modeling Zonal Mean Zonal Wind With Fluctuating Gaussian Jets

Mitch Bruce
University of Victoria
Contact: mitch@uvic.ca

A systematic EOF analysis is applied to the Southern Hemisphere (SH) zonal-mean zonal wind (ZMZW) in order to determine how sector width affects the shape and ordering of the empirical orthogonal functions (EOFs). Wider sector EOFs are found to compare favorably to previous work, (Monahan and Fyfe 2006 for example), but show a progressive lack of robustness depending on the location of the center of the sector as it is narrowed. A kinematic model based on a fluctuating Gaussian-shaped jet is then used to model the observational EOFs in order to further characterize the variability of the jets. Data and model EOFs are compared at several different pressure levels to determine the relative importance of the eddy-driven and sub-tropical jets on EOF shape and ordering."

2D01.4 ID:3307 17:00

Modeling Alternating Zonal Jets in the Fluid Dynamics Laboratory

Sheilagh O'Leary [1], *Yakov Afanasyev* [2]
[1] Student
[2] Professor

Contact: soleary@mun.ca

Alternating mesoscale zonal jets with persistence in time as predicted by turbulence theory were recently observed by satellite altimetry in the Pacific Ocean in maps of geostrophic velocity and were observed separately in numerical models of the ocean. The rotating cylindrical platform in the fluid dynamics laboratory provides a simplified and controlled environment for modeling the dynamics of the oceanic circulation. We show a mechanism whereby the jets result from the development of beta-plumes originated from the baroclinic meanders at the eastern boundary of the ocean. The underlying dynamics include the propagation of linear and nonlinear basin scale Rossby waves. We demonstrate this mechanism using a rotating axisymmetric bowl of fluid with a paraboloidal free surface. The dynamical fields are measured by the altimetric imaging velocimetry (AIV) and optical thickness methods. The dynamical similarity and the control parameters of the laboratory flows are compared to the in situ observations of the North Pacific Ocean.

2D01.5 ID:3879 17:15

Basin and Channel Contributions to a Model Antarctic Circumpolar Current

Louis-Philippe Nadeau
McGill University
Contact: louis-philippe.nadeau@mail.mcgill.ca

A conceptual model for explaining the Antarctic Circumpolar Current (ACC) transport problem is presented. The total transport is considered as the sum of a basin-like and a channel-like contribution. Our focus is primarily on the basin-like dynamics and its role in determining the total transport. The starting point is the classic mid-latitude ocean gyre problem in the context of the stratified quasigeostrophic equations. We then apply this dynamics to the basin region of the Southern Ocean, north of Drake Passage. In this case, the baroclinic structure of a Sverdrup flux entering the channel region determines what fraction of this flux contributes to the ACC and what fraction is blocked by the bottom topography, feeding a recirculation gyre. This gives a simple analytic model describing the relationship between the wind stress and the transport. Two distinct dynamical regimes are found for the basin contribution: a Stommel regime, for which transport increases linearly with forcing strength and a saturation regime, for which the transport levels off. The robustness of these ideas to the presence of a vigorous eddy field is then tested numerically.

General Hydrology Session (Part 3) / Séance générale sur l'hydrologie (Partie 3)

Room / Endroit (Ballroom B), Chair / Président (James Buttle), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D02.1 ID:3636 16:00

Streamflow forecasting by machine learning methods utilizing numerical weather prediction and climate indices

Kabir Rasouli [1], *William Hsieh* [1], *Alex Cannon* [2], *Carlos Gaitan* [1]
(Presented by *W. Hsieh*)
[1] Dept. of Earth and Ocean Sciences, University of British Columbia, Vancouver, BC
[2] Meteorological Service of Canada, Vancouver, BC
Contact: whsieh@eos.ubc.ca

River flow as a main indicator of water availability in a watershed has direct effect on power generation rate, agriculture and industry sectors, and water quality, as well as environmental issues due to probable flood or drought occurrence. Streamflow fluctuates as a result of different atmospheric, hydrologic, and morphologic mechanisms governing a river watershed. Variability of meteorological variables such as rainfall, temperature, wind, sea level pressure, humidity, and heating, as well as large scale climate indices like the Arctic Oscillation, Pacific/North American Pattern, North Atlantic Oscillation, and El-Niño Southern Oscillation, play a role on the availability of water in a given basin. Considering the complexity of the meteo-hydrologic phenomena, developing a robust nonlinear algorithm to forecast river flow from applying local and regional climate forecasting systems is very important in water management. In this study, data generated by the NOAA Global Forecasting System (GFS) model, climate indices, and observed data from meteo-hydrorologic stations are used to forecast daily streamflows. Three nonlinear machine learning methods -- support vector regression (SVR), Gaussian process (GP), and Bayesian neural network (BNN) -- are used, and compared with multiple linear regression (MLR). Lead time for forecasting varies from 1 to 7 days. This study has been applied to a small coastal watershed in British Columbia, Canada. The results show that when the lead time increases, climate indices such as the Arctic Oscillation and North Atlantic Oscillation become more important on influencing the flow variability. Model comparisons show the BNN model to slightly outperform the GP and SVR models and all three nonlinear models perform better than the MLR model.

2D02.2 ID:4096 16:15

Impacts of Hydrogeological Process on Cone Karst Landscape, Formation and Local Tourism Development: A Case Study in Xingyi, China

Kejian Xu [1], *Xingzhong Li* [2], *Jiaqi Liu* [3]
[1] China University of Geosciences, Beijing
[2] Academy of Geoengineering Survey, Guizhou Bureau of Geology&Mineral Exploration&Development,Guiyang
[3] Institute of Geology and Geophysics, Chinese Academy of Sciences,Beijing, China 100029

Contact: kejian77@foxmail.com

This paper analyses impacts of hydrogeological processes on the cone karst landscape and its formation from the perspectives of hydrogeology and geomorphology, using a case study in Xingyi region, Guizhou Province, China, the most comprehensive and typical cone karst distribution region around the world. We also discuss the influence of the karst landscape processes to local tourism development. As one of the three major types of karst landscapes the world, cone karst distributes mainly in the low-latitude and humid tropical and subtropical climate zones, especially concentrates in southern China. Cone karst shows not only a unique morphology with combination of the plus and minus geomorphologic features, hydrodynamic processes, but also special dynamic models and evolutional processes that related to change of the hot and humid climate. Consequently, these special features play roles in controlling the hydro-geological structures of the cone karst landscape. These unique hydro-geological processes determine the special ethic value for sightseeing, restriction on tour capacity, and characteristics of spatial distribution of local tourism development, which become the foundation and key factors for local tourism development and planning.

2D02.3 ID:4059 16:30

Temporal Variation of Irrigation Drainage Water Quality, Southern Alberta

Gro Lilbaek [1], *Gary Kachanoski* [1], *Andrea Kalischuk* [2], *Norman Neumann* [3]
[1] Department of Renewable Resources, University of Alberta, Edmonton, AB, Canada
[2] Alberta Agriculture and Rural Development, Lethbridge, AB, Canada
[3] Provincial Laboratory for Public Health, Edmonton, AB, Canada
Contact: gro.lilbaek@ualberta.ca

Pathogenic microorganisms are potential threaten water quality and thereby pose a risk to humans, aquatic life and wildlife. Better understanding of the transport of microorganisms is essential to ensure safe drinking water in rural and agricultural areas. This research looks at the temporal and spatial dynamics of microbial contaminants in relation to inorganic ions and trace elements along a major transport pathway, an irrigation drain, in southern Alberta. The area has a high density of intensive livestock operations (mainly cattle) and manure is commonly used as fertilizer. Furthermore, the majority of farmsteads in the area use septic systems for treatment of wastewater and a portion of them rely on shallow groundwater as their water supply. Thus, potential contamination of groundwater is of great concern in this area. Ten sampling sites were selected along the ~20 km Battersea Drain. All sites were sampled on a bi-weekly basis during flow (August till October). Following drain shut-off (mid October) sampling shifted to monthly. To assess the impact of the drain's water quality on the groundwater a transect of eight groundwater wells, following the general flowpath of the area's groundwater (parallel to drainage), were sampled simultaneously; continuing throughout the winter. Samples were analyzed for major inorganic ions, nutrients, total coliforms, total E. coli, as well as pathogenic microbiological species such

as E. coli O157:H7, Salmonella, Giardia, and cryptosporidium spp. Results showed little variation in the inorganic chemical composition of the drain water during flow, but total coliforms and total E. coli, varied significantly both temporally and spatially. Following drain shut-off, significant increases (some >10 fold) were observed for inorganic ions where as microbial content decreased significantly (some to <1 MPN/100 ml). Groundwater contamination by microorganisms was localized in one area along the drain, but little temporal variation was observed in the inorganic composition.

2D02.4 ID:3942 16:45

Spatio-Temporal Assessment of Streamflow Generation to the Athabasca River Delta: Implications for Upstream Development

Daniel Peters [1], *Wendy Monk* [2], *Donald Baird* [3]
[1] Environment Canada @ Climate Impacts Research Centre, University of Victoria, BC
[2] Canadian Rivers Institute, University of New Brunswick, Fredericton, NB
[3] Environment Canada @ Canadian Rivers Institute, University of New Brunswick, Fredericton, NB
Contact: daniel.peters@ec.gc.ca

The Athabasca River in northwestern Canada, the dominant inflow to Lake Athabasca and Peace-Athabasca Delta complex, continues to be influenced by multiple environmental stressors on its hydrology and aquatic ecology, including land-use change, climate variability/change, industrial and municipal water uses. An emerging issue regarding the hydrology and aquatic ecology of this internationally recognized and transboundary complex is the abstraction of water for the processing of oil-sands deposits located in the lower Athabasca River region of northern Alberta. The rapidly expanding development of the oil-sands region and the projected need for more water abstraction from the Athabasca River system poses potential impacts on downstream deltaic ecosystems. Flows on the lower Athabasca River just below Fort McMurray have been on average ~650 cms, with minimum flows of <200 cms during the winter period and mean peak flows of 2500 cms during mid-summer). The observed historical high flow was 4700 (July 1971) and the low flow was 75 cms (December 2001). Historical winter flow conditions have occurred and will very likely re-occur that would put the river in “red zone” of the proposed instream flow needs (IFN) recommendation developed by Alberta Environment and Department of Fisheries of Oceans, even in the absence of water withdrawals. A number of hydrological issues are not explicitly considered in the IFN recommendations under development, e.g., water availability and sustainability of IFN in a varying and changing climate. The goal of this study, the second in a series tackling these hydrological issues, is to examine the historical production of key ecologically relevant streamflow variables (e.g., magnitude and timing of peak and low flows) at the Athabasca Delta. The study of the geographical origins of streamflow (alpine vs. foothills vs. lowland) at key times of the year will enhance our understanding of possible future impacts of additional development schemes.

2D02.5 ID:3858 17:00

Carbon flux response of a harvested Boreal aspen forest, a comparison between natural conditions and stand recovery

Kayla Giroux [1], *Rich Petrone* [1], *Scott Brown* [1], *Kevin Devito* [2]
[1] Wilfrid Laurier University
[2] University of Alberta
Contact: giro7560@wlu.ca

The Utikuma Region Study Area (URSA) is located in north-central Alberta, Canada, in a region where aspen (Populus Tremuloides Michx.) dominate the upland vegetation of the Western Boreal Plain (WBP). Due to the heterogeneity of the surficial geology as well as the sub-humid climate where the water balance is dominated by evapotranspiration, the carbon balance across this landscape is highly variable. Moreover, the upland aspen regions represent significant stores of carbon. More recently, aspen stands have become valuable commercial resources for pulp and paper processing. These stands are harvested through clear cutting and are generally left to regenerate on their own, a process which occurs rapidly in clonal species like aspen. At URSA, three eddy covariance towers were setup during the length of the growing seasons of 2005-2009 to investigate the CO2 exchange under natural conditions and the rate of recovery after harvest. In 2007, the south facing slope of URSA was harvested and the north facing slope in 2008. This study examines the inter-annual variability in net ecosystem productivity (NEP) and its relationship with air temperature, precipitation, soil moisture, growing season length, LAI, and finally as a result of recovery after harvest.

2D02.6 ID:3714 17:15

Rainfall interception in mature lodgepole pine forests at risk from Mountain Pine Beetle attack in Alberta

Pablo Pina-Poujol , *Uldis Silins* , *Sue-Ellen Macdonald*
(Presented by *Pablo Pina*)
University of Alberta
Contact: ppina@ualberta.ca

This research examines forest canopy and forest floor interception as components of vertical stand water balance in a mature lodgepole pine forest. The research is a part of a larger study focused on changes in forest water balance in response to a mountain pine beetle attack in the foothills region of western Alberta. Interception was measured indirectly in several 120 years old (24-26 m high) lodgepole pine stands using measurements of throughfall and stemflow. Universal precipitation and tipping bucket rain gauges along with throughfall troughs and stemflow gauges were used to measure canopy interception for the 2008 and 2009 summer season. The forest floor water holding capacity was established for four different categories of forest floor litter from an experiment conducted during the summer of 2009. Across the summer seasons, average canopy interception storage capacity was 8.1 mm, but 85 % of

the summer storm precipitation events were less than 6 mm. Over these two summers, total canopy interception losses accounted for 49% of total summer rainfall. Net precipitation to the forest floor was dominantly comprised of throughfall (47% of gross precipitation) while stemflow only accounted for an additional 4%. Depending on the nature of the rainfall (duration and intensity) and the dryness of the forest floor, the forest floor interception capacity could be as high as the canopy interception capacity (1.18 mm/cm of forest floor thickness). Results indicate that summer rainfall interception dynamics result in only infrequent moisture recharge thus soil moisture recharge of a lodgepole pine forest in western Alberta is dominated by the winter snowfall period.

Weather and Society - Integrated Studies (Part 3) / La météo et la société - Études intégrées (Partie 3)

Room / Endroit (Ballroom C), Chair / Président (Rebecca Wagner), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D03.1 ID:3900 **16:00**

Weather-Based Decision Support Tools for Agriculture – WeatherFarm

Guy Ash
WeatherFarm.com/The Canadian Wheat Board
Contact: janderson@weatherbug.com

Localized, real-time weather information is vital for day-to-day agronomic management of all crops. The challenge for agriculture is twofold in that local and timely weather data is not often available for producers, and it is not integrated into decision-support tools they require.

Many of the traditional sources of weather information are not sufficient for agricultural applications because of the long distances between weather stations, meaning the data is not always applicable for on-farm decision making processes. The second constraint with traditional weather information is the timeliness of the data. Most delivery systems are designed on a one-hour time step, whereas many decisions in agriculture are based on minute-by-minute weather conditions. This is especially true for decisions surrounding chemical and fertlizer application and frost events.

This presentation will outline how the creation of a turnkey decision-support system, WeatherFarm, was designed to provide producers with live, local weather conditions. This, in turn, is integrated into decisions surrounding numerous on-farm agronomic activities such as pest management, or dealing with heavy rainfall and frost events. Agronomic models can be used to assess the potential of disease pressure, enhance the farmer's abilities to time pesticide applications, or assess conditions contributing to yield and quality fluctuations. WeatherFarm also enables farmers and industry stakeholders to view quality-assured historical weather variables at any location. This serves as a record-management tool for viewing previously uncharted agronomic weather events in graph or table form. This set of weather tools is unique and provides a significant enhancement to the agronomic decision-support process.

Direct benefits to growers can take the form of increased yield and grade potential, as well as savings in money and time. Pest management strategies become more efficient due to timely and localized disease and pest modelling, and increased efficacy of pest and weed control.

2D03.2 ID:3869 16:15

The Meteorological Service of Canada's Interactive Database Project – Meteo4U Framework

Kenneth Kwok , *Gabor Fricska* , *Jean-Philippe Gauthier* , *Alexandre Leroux* , *Kevin Ngai*
Environment Canada
Contact: ken.kwok@ec.gc.ca

The Meteorological Service of Canada (MSC) at Environment Canada generates and stores a large volume of environmental information everyday. Predefined and widely available products such as public weather forecast bulletins, warning bulletins, and various numerical weather charts are on the Weatheroffice and Datamart websites and are used as our means to communicate a small subset of this information. Aside from these products, the Canadian public currently cannot easily access the majority of the data that is generated by MSC.

With recent technological advances, a more useful method to access MSC data is now being developed. Through the use of an interactive web map interface, currently named Meteo4U, the public will have the ability to choose the products they want and the ability to download data used to generate these products. Users of Meteo4U will be able to display a range of meteorological forecast data (e.g. temperature, wind speed, precipitation) by interactively defining: 1. a geographic location, 2. a travel route, or 3. an area on a map.

Meteo4U can provide weather data and forecasts using standard geospatial web services from the Open Geospatial Consortium, such as the Web Map Service (WMS) and Web Feature Service (WFS), allowing clients and partners to integrate meteorological data directly and seamlessly into the tool of their choice, such as Google Earth, ArcGIS or another web map.

This project is one of the first official initiatives to use modern geospatial technologies to interactively share, distribute and disseminate meteorological data at the MSC.

2D03.3 ID:3867 16:30

A Summary of Feedback Received from MSC's Street Level Forecast Prototype

Gabor Fricska [1], *Lisa Vitols* [2], *Ken Kwok* [1]
[1] Meteorological Service of Canada
[2] Meterological Service of Canada
Contact: gabor.fricska@ec.gc.ca

The Meteorological Service of Canada carried out a test of a prototype named Street Level Forecast (SLF) for a 9 weeks period that included the 2010 Olympic and Paralympic Winter Games. It consisted of an interactive web map interface linked to the 1 km GEM Local Area Model and was hosted on Environment Canada's WeatherOffice website. The domain of the SLF was confined to an area of southwestern BC surrounding the 2010 Games venues. Users were able to obtain graphical or text- based point forecasts by clicking on the interface or by entering a street address, lat/long or postal code. Hourly forecasts of several weather elements were presented in both graphical and tabular formats. Feedback from users of the SLF was solicited through the website and from other regular users of meteorological data. A summary of the qualitative and quantitative feedback will be presented.

2D03.4 ID:3952 16:45

The "Window on Weather" trial service: Engaging Weather-Sensitive Decision-Makers

Lyn Mainwaring
(Presented by *Mainwaring Lyn*)
Environment Canada
Contact: lyn.mainwaring@ec.gc.ca

Results from consultations with a variety of weather-sensitive decision-makers across Canada show a common theme: better access to weather service staff can help in their decision-making. As a result, the National Service Office of the MSC in Kelowna, B.C. launched a trial service where decision-maker participants can join a daily web conference to discuss weather-related issues. The goal is to help participants make better weather-related safety and/or business decisions. Typical participants include personnel in emergency management, engineering/utilities, water stewardship, road maintenance, parks and school transportation. Feedback from the first two phases of the trial is very encouraging with many positive comments. Participants generally find the service useful, relevant and timely. As expected, dialogue usually begins with traditional weather briefing Q and A, but other interesting knowledge-sharing discussion often

develops. These conversations tend to help all parties gain a better understanding of each other's individual operations, needs and challenges. This appears to lend itself to an increased sense of trust among those involved and, in general, promotes improved working relationships.

2D03.5 ID:3996 17:00

Hazardous Weather in Iqaluit, Nunavut: Perceptions, Impacts, Vulnerabilities, and Adaptations

Jadah Folliott , *Gordon Mcbean* , *Karen Pennesi*
University of Western Ontario
Contact: jfolliot@uwo.ca

Weather and climate change pose risks to many Northern residents, particularly those who depend on resource-based activities. This study is part of the multidisciplinary ArcticNet and Storm Studies in the Arctic (STAR) projects looking at the ways Northern communities cope with atmospheric hazards, and how these strategies can be improved. The capacity to prepare for and cope with hazardous weather and related events requires more than access to scientific weather knowledge. Residents who depend on the land for their wellbeing also employ local knowledge to cope with hazardous weather and the changes they are experiencing. This paper focuses on how long-term residents of Iqaluit, Nunavut access, perceive, and use scientific weather forecasts, and how local weather knowledge is generated and used by residents. During July-August 2009, 37 semi-structured interviews were conducted with Inuit and non-Inuit long-time residents of Iqaluit who are knowledgeable about the local weather. Iqaluit is unique to the North in that it has a relatively large, diverse population and a high proportion of newcomers, both from the south and from other northern communities. This study has revealed that long-term residents employ a variety of ways of knowing about the weather and other weather-related hazards, including integrating local weather knowledge and scientific weather forecasts, but perhaps most importantly, that no one person has all the information required to make fully informed decisions about the risk associated with different activities and locations out on the land. Even long-term residents have restricted access to local weather knowledge (e.g. due to cultural or linguistic barriers, age, etc.). This case study reveals the need for essential weather services tailored to all community members. It is critical for residents, including newcomers to the community, to have access to local weather knowledge in order to help reduce social vulnerability and improve coping strategies.

2D03.6 ID:3719 17:15

Understanding local perspectives of 'severe weather' in Pangnirtung, Nunavut

Jennifer Spinney , *Karen Pennesi*
University of Western Ontario

Contact: jspinney@uwo.ca

In June of 2008, residents in Pangnirtung, Nunavut experienced accelerated snowmelt and heavy rains which caused the development of cracks in the permafrost and erosion of the Duval River's shoreline, as well as the collapse of public infrastructure. With funding provided by ArcticNet, the research explored the perceived causes and effects of this particular event and attempted to learn on a broader scale, firstly, what types of weather constitute disastrous and severe, and secondly, how residents produce, interpret, and utilize predictions of severe weather. Methodologies for this research included 3 months of participant observation, 27 formal interviews, and 2 focus group discussions with Inuit and non-Inuit members of the community. Many residents indicated that the temperatures and wind strength during the event in June of 2008 were normal. Furthermore, while characterizations of the event were magnified by political representatives and the media, several residents pointed out the immediate effects to the land and impacts to the community were at best exciting, and at worst, inconvenient. The results of the research highlight the dynamic nature of weather knowledge and emphasize the need for culturally specific definitions for terms such as 'severe weather'. Moreover, the findings reveal the ways in which vulnerability to significant weather events and environmental change is perceived by community members. Overall, understanding how residents living in the Arctic define and actively cope with atmospheric hazards will allow the scientific community to be of better assistance to community leaders in the North as they develop action plans and prepare for future weather events.

General Atmospheric Sciences (Part 2) / Séance générale sur les sciences atmosphériques (Partie 2)

Room / Endroit (Richelieu), Chair / Président (Pierre Gauthier), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D04.1 ID:3736 16:00

Observability of flow dependent structure functions and their use in data assimilation

Pierre Gauthier [1], *Cristina Lupu* [2]
[1] Université du Québec à Montréal (UQAM)
[2] ECMWF, Reading, UK
Contact: pierre.gauthier@uqam.ca

One of the objectives of data assimilation is to produce initial conditions that will improve the quality of forecasts. Studies on singular vectors and sensitivity studies have shown that small changes to the initial conditions can sometimes lead to exponential error growth. This has motivated research to include flow-dependent structures within the assimilation that would have the characteristics to correctly predict the growth or decay of meteorological systems. This relates to the characterization of precursors to atmospheric instability. In this presentation, the observability of such structures by observations is discussed. Several studies have shown that deploying observations over regions where changes in the initial conditions may impact the forecast the most do not lead to the expected benefit. It is shown that given the small magnitude of the signal to be detected, it is important to take into account the accuracy of the observations. If the signal-to-noise ratio is too low, observations cannot detect and characterize precursors to forecast error growths. From that perspective, the assimilation only has the possibility to extract information about evolved structures of error growth. Experiments with a simple 1D-Var system are presented and then, with an adapted 3D-Var system with different sensitivity structure functions is used. The results have been obtained by adapting the variational assimilation system of Environment Canada.

2D04.2 ID:3726 16:15

The Canadian Regional Data Assimilation and Forecasting System

Luc Fillion [1], *Monique Tanguay* [1], *Ervig Lapalme* [1], *Bertrand Denis* [1], *Michel Desgagne* [1], *Vivian Lee* [1], *Nils Ek* [1], *Zhuo Liu* [1], *Manon Lajoie* [1], *Jean-Francois Caron* [1], *Christian Page* [2]
[1] Environment Canada
[2] UQAM
Contact: luc.fillion@ec.gc.ca

This talk will describe the recent changes to the regional data assimilation and forecasting system at the Canadian Meteorological Center. A major aspect is the replacement of the currently operational global variable resolution forecasting approach by a limited-area nested approach. As a first version of the new system, similar background error statistics, same computer resources and exact same data availability have been considered.

Under such conditions, it is shown that the new regional data assimilation and forecasting system performs as well as the current operational system as judged from an ensemble of winter and summer cases and produces slightly better 24-h accumulated precipitation scores. Details on this performance and upcoming important upgrades will be discussed.

2D04.3 ID:3940 16:30

Characterizing Environment Canada's global short-term forecasts of surface winds over the global ocean: the role of an appropriate comparison

with scatterometer ocean wind vector observations

Robert Tardif [1], *Stephane Laroche* [1], *Mateusz Reszka* [2], *Judy St-James* [2]
[1] Meteorological Research Division, Environment Canada
[2] Meteorological Service of Canada, Environment Canada
Contact: Robert.Tardif@ec.gc.ca

The representation by numerical forecast models of low-level atmospheric flows over oceans is of significant importance for a wide variety of applications. Information from model-derived near-surface winds, or alternatively wind stress, is needed by oceanic applications such as ocean surface drift prediction systems for search and rescue purposes and is central to the coupling of atmospheric and oceanic numerical models. Comparisons between model-diagnosed surface winds and spaceborne scatterometer observations, through data assimilation systems, provide a wealth of information on the system's global performance with respect to short-term forecasts of atmospheric flows within the marine boundary layer. Scatterometer ocean wind vectors are routinely assimilated into Environment Canada's operational global assimilation and forecast system. Observations from the SeaWinds sensor onboard the QuikScat satellite have been assimilated since May 2008 until its end of operational life in November 2009, while observations from the Advanced SCATterometer (ASCAT) onboard the Metop-A satellite have been introduced in April 2009.

Scatterometer wind retrievals are calibrated as an "equivalent neutral" wind, a variable more closely related to surface wind stress than the stability-dependent wind profiles predicted by forecast models. This calibration is performed due to the direct scatterometer response to the centimeter-scale surface roughness created by capillary waves induced by the wind stress relative to the ocean surface. Therefore, an appropriate translation of model output to scatterometer observation space (observation operator) has been designed to gain a more accurate estimation and characterization of differences between observations and the model wind (innovations). Improved estimation of wind innovations is among the first steps toward enhancing the assimilation of scatterometer data and provides the basis for a more accurate evaluation of model biases. The concept of equivalent neutral wind will be discussed, the new observation operator and its characteristics will be presented, along with a characterization of the systematic discrepancies between the model and observations.

2D04.4 ID:3620 16:45

Refinements in the Assimilation of ASCAT Scatterometer Winds at MSC

Mateusz Reszka [1], *Stéphane Laroche* [2], *Robert Tardif* [2], *Judy St-James* [1]
[1] Meteorological Service of Canada, Environment Canada
[2] Meteorological Research Division, Environment Canada
Contact: mateusz.reszka@ec.gc.ca

Wind speed and direction based on retrievals from the Advanced Scatterometer

(ASCAT) instrument have been assimilated in the operational global 4D-Var forecast system at MSC since April 2009. ASCAT is a C-band scatterometer on-board the first Meteorological Operational (MetOp-A) satellite, operated by EUMETSAT. Since the SeaWinds instrument was taken offline in late November 2009, ASCAT measurements have been the only scatterometer wind observations ingested operationally. Inclusion of this data set was previously shown to have a positive impact on forecast skill, however biases originating from several different sources still remain. After an investigation of the most obvious biases, adjustments in the quality-control and assimilation procedures were proposed and tested in a simplified assimilation scheme, with the goal of eventual implementation in the operational system. In particular, large, persistent O-F errors were found to appear at high latitudes near the edge of sea-ice. Detection of these contaminated observations using the MSC operational ice analysis and their removal from the assimilation provides a small but significant benefit in terms of forecasts at lead times of 1 to 5 days. This is evident from verifications against radiosonde observations as well as verifications against analysis. It is also shown that the algorithm used to decrease the spatial resolution of the ASCAT data inadvertently enhances certain instrument biases. A reformulation of this thinning procedure improves the distribution of the observations as a function of speed and cross-track position. Introduction of flow-dependent covariances between the vorticity and divergence fields using forecasts from a parallel Ensemble Kalman Filter assimilation system will also be discussed.

2D04.5 ID:3444 17:00

Environment Canada Weather Services in Support of Pan AM 2015 Games in Toronto

Richard Campbell
Environment Canada
Contact: Richard.Campbell@ec.gc.ca

The 17th Pan-American and Para-Pan American Games are to take place in Toronto, Ontario, Canada and its surrounding area during July of 2015. Over 40 countries from the Americas are expected to participate. The actual size of the 2015 Games will be greater than that of the Vancouver 2010 Games although the public profile will not be as high.

In support of its mandate, Environment Canada will be responsible for ensuring the safety and security of the general public from severe or significant weather, including athletes, officials, and volunteers at the Games. Weather forecast challenges include convective initiation, lightning, wind shifts (for sailing events) and general severe weather affecting public and athlete safety.

Throughout the Games, Environment Canada will provide area-wide severe weather watches, warnings and advisories in order to alert the public, as well as general 7-day forecasts for everyday planning activities.

There will be an estimated five principal outdoor venues scattered throughout the Greater Toronto Area. Therefore, Environment Canada will also provide special weather warnings and forecasts for venue-specific sites in order to ensure the safety and security of all athletes, spectators, and officials, as well as additional weather training and consultation of services for Games partners. Additional area-wide and venue-specific surface land, marine and upper air weather monitoring stations will be needed. These additional weather services will require a multi-year project in order to provide the level of service demanded for the events. Fully installed systems must be ready for integrated testing approximately two years before the 2015 event.

2D04.6 ID:3474 17:15

The Canada-China Forecaster Exchange of 2009

Stephen Miller [1], *Mitch Meredith* [2]
[1] MSC Atlantic
[2] MSC Ontario
Contact: steve.miller@ec.gc.ca

In November and December of 2009, the Meteorological Service of Canada and the Chinese Meteorological Administration organized a forecaster exchange. Two operational meteorologists from China visited Canada in early November, and two forecasters from Canada spent one week working in Beijing in early December. This presentation will provide information on the structure of the Chinese weather service, some of the lessons learned from the forecaster exchange, and recommendations on future cooperation between the MSC and the CMA.

Most of the visit was spent at the Chinese National Meteorological Center, which plays a similar role as Canada's CMC. China's NMC is actually a complex of several buildings which house things such the operations center, supercomputer, satellite centre, training center and even a separate building for China's version of the weather network. The Canadian meteorologists presented a brief introduction to Canada's MSC to the operations staff at NMC. The Chinese meteorologists seemed to be mainly interested in the structure of our severe weather watches and warnings.

The final day of the trip was spent at the Beijing Weather Office, which is similar to one of our Storm Prediction Centres. The Beijing office exhibited many similarities in look and feel to the regional offices in Canada. It was comforting to see that the science of meteorology would function this way despite the many cultural differences between the two countries.

The exchange proved to be a valuable experience for us. It was interesting to see how things were approached in a different country and a very different culture. Our Chinese hosts were very helpful and cordial, and they ensured that we enjoyed our time in Beijing. We recommend that these exchanges continue in future years.

Geophysics in sensitive environmental sites (Part 1) / Géophysique dans les sites écologiquement vulnérables (Partie 1)

Room / Endroit (Frontenac), Chair / Président (Claire Samson), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D05.1 ID:3398 16:00

Nonlinear Bayesian simulation algorithm to infer heterogeneous porosity field using synthetic GPR tomographic data and porosity logs.

Camille Dubreuil-B. [1], *Erwan Gloaguen* [1], *Denis Marcotte* [2], *Bernard Giroux* [1]
[1] INRS-ETE
[2] École Polytechnique de Montréal
Contact: camille.dubreuil-boisclair@ete.inrs.ca

This study explores the use of a nonlinear Bayesian simulation algorithm to infer heterogeneous 2D porosity field at a decimetric scale. The proposed method is tested on a synthetic heterogeneous porosity model from which synthetic GPR velocity and attenuation tomographic data are generated. Firstly, a prior porosity distribution is estimated, under Gaussian hypothesis, by simple kriging of the log porosity extracted from two fictive boreholes on the model. Secondly, the likelihood function of porosity is obtained from a kernel probability density function estimator describing the relationship between collocated log GPR velocity and attenuation data and porosity along boreholes. Finally, using a sequential approach, the prior porosity distribution is combined to the likelihood pdf to obtain an updated final distribution from which a porosity value is randomly picked.

2D05.2 ID:3404 16:15

Instrumenting a Bioreactor Landfill to Measure the Physical Properties of Waste

Emily Vingerhoeds [1], *Paul Van Geel* [1], *Claire Samson* [2]
[1] Department of Civil and Environmental Engineering, Carleton University
[2] Department of Earth Sciences, Carleton University
Contact: evingerh@connect.carleton.ca

This research is part of a three-year effort to instrument a cell in a bioreactor

landfill as it is progressively filled with waste. The field research is being conducted at an operational bioreactor landfill in Ste. Sophie, Quebec, in coordination with Waste Management of Canada. This waste-to-energy facility accepts close to one million tonnes of waste each year and generates approximately 9000 m3/h of landfill gas which provides 4000GJ/d of energy to a nearby pulp and paper mill. The overall goal of this research is to better understand the waste stabilization process for bioreactor landfills located in colder climates. Twelve instrument bundles will be installed within the waste in two vertical profiles. The instrument bundles include a range of sensors to record the temperature, oxygen content of the air space, moisture content, electrical conductivity, total load and settlement. This data will provide valuable insight into key parameters that impact the waste degradation and stabilization processes. A GPS system has been installed on two compactors to evaluate the operational practices at the site (e.g. lift thickness, number of passes per lift, compaction for each pass, etc.) This knowledge will allow landfill operators to tailor their operational practices to optimize the use of landfill space and increase gas production for power generation.

This presentation will describe the testing of the sensors chosen for the project to increase their chances of survival in the harsh landfill environment. The initial deployment of the sensor bundles as the waste is placed will be discussed. Data collected from each instrument bundle are stored in a datalogger on-site, which can be remotely accessed in real-time. Several preliminary data sets collected by the instrument bundles will be presented, showing how the various parameters are changing over a time-scale of a few weeks to a few months.

2D05.3 ID:3408 16:30

High Frequency GPR Imaging of a Shallow Gasoline Release over an Annual Cycle

Cameron Mcnaughton , *Anthony Endres* , *John Mosquera* , *Juliana Freitas*
University of Waterloo
Contact: alendres@sciborg.uwaterloo.ca

Our hydrogeophysical field experiment evaluated the ability of high frequency (450 & 900 MHz) ground penetrating radar (GPR) to characterize the release of gasoline over an annual cycle of in situ conditions. In August 2008, 200 liters of E10 gasoline were released into the unconfined sand aquifer at CFB Borden. The 900 MHz profiling clearly shows the development of shallow (i.e., above 10 ns) high reflectivity in the vicinity of the trench immediately after the release. Additional lateral extension of high reflectivity zone was observed over the following 20 days until the seasonal water table low stand occurred, after which no further lateral movement was observed. Throughout the remainder of the monitoring, the 900 MHz profiling observed a long-term dimming of reflectivity at the periphery of the impacted zone.

While direct imaging of the shallow impacted zone by the 450 MHz antennas was

significantly obscured by the superposition with the direct air-ground wave arrival; its improved depth of penetration allow the measurement of a velocity "pull-up" of an underlying stratigraphic interface resulting from the displacement of low velocity water by high velocity gasoline. The maximum pull-up was observed during the water table low stand. The ongoing changes in the pull-up magnitude during the remainder of the observation period suggest that the continued redistribution of fluids in the impacted zone.

Because of the shallow depth of the gasoline impacted zone, the effects of freezing during the winter period were observed in the GPR imaging. The presence of the gasoline impacted zone appears to have affected the depth of freezing, causing a depression of the frozen soil base. The dimming of the direct air-ground wave complex indicates that the contaminant phase brought to the surface by the water table fluctuations have impacted the nature of the near-surface freezing.

2D05.4 ID:3470 16:45

An efficient methodology to built hydrogeological numerical model of shallow aquifer using GPR, ERT et CPTu data integration in gOcad

Christine Bélanger [1], *Erwan Gloaguen* [1], *Renné Lefebvre* [1], *Bernard Giroux* [1], *Daniel Paradis* [2], *Jean-Marc Ballard* [1], *Laurie Tremblay* [1]
[1] INRS-ETE
[2] Geological Survey of Canada
Contact: christine.belanger@ete.inrs.ca

It is widely known that an integrated characterization approach is necessary to define the geometry, internal structure, the heterogeneity of the material distribution and water composition of the aquifers at acceptable costs. Multiple geophysical and hydrogeological data were measured in the subwatershed surrounding a former unlined landfill: hydrogeological data in 25 direct push full-screen wells (slug tests, water conductivity, water levels), 21 Km of GPR, 5 Km of 2D electrical tomography and 30 cone penetration tests (CPT)u with soil moisture resistivity (SMR). The CPTu soundings were guided based on the GPR data in order to maximize the information and to minimize the costs. In the same manner, the well installation was decided based on the data integration of all the geophysical data. Finally, the 3D data integration in gOcad facilitates data interpretation and provides the basis for a detailed numerical groundwater flow and transport models.

Keywords-component; GPR; CPT; ERT; geostatistics

2D05.5 ID:3755 17:00

Geophysical monitoring of a large-scale infiltration in a heterogeneous urban fill

Tshibi-Tshiabu Mwamba [1], *Jean-Sébastien Dubé* [1], *Michel Chouteau* [2],

Abderrazak Boucheda [2], *Erwan Gloalguen* [3], *Myeong-Jong Yi* [4]
[1] École de Technologie Supérieure
[2] École Polytechnique
[3] Institut national de la recherche scientifique
[4] Korea institut of geosciences and mineral ressources
Contact: jcmwamba@gmail.com

The goal of this study was to assess the contribution of geophysical methods coupled with flow modeling to understand the hydrodynamics of highly heterogeneous anthropogenic soils, namely urban fills, in the context of groundwater protection. Urban fills are generally made of a heterogeneous mixture of various wastes and soil and they are usually considered as contaminated land in most legislations. Moreover, the heterogeneous structure of these fills, and hence its influence on water flow inside them, is difficult to characterize using conventional methods based on borehole drilling. In contrast, geophysical methods can sample a larger volume while producing a high density of data, and bridge the data gaps left by conventional methods. To characterize the influence of structure heterogeneity on flow dynamics, a large-scale controlled infiltration experiment was conducted and monitored using electrical resistivity tomography (ERT). The study area was 5x4 m2 and the thickness of the fill at the site was 2.5 to 3m. A controlled irrigation of the test surface was performed with a rainfall simulator. Resistivity measurements were made by pushing into the ground a set of 9x7 electrodes with a 1m spacing. Thirty others electrodes were installed in five boreholes drilled at the corners and the center of the test area. Following the infiltration, the site was excavated to confirm the geophysical data. Samples were taken from different materials identified and their retention properties determined using the Arya and Paris model for modeling the unsaturated part of the fill. The inversion of the data was performed with a four- dimensional imaging algorithm. The results show the usefulness of the TRE to characterize the infiltration in these very heterogeneous environments. A resistivity modeling was made with the Res3dmod software in order to validate the field measurements and to improve data interpretation. Based on this model of resistivity and field observations, a hydrogeologic model was developed to study the flow in the fill.

2D05.6 ID:4085 17:15

Unconsolidated sediment mapping using multi-component seismic reflection data in the Richelieu (QC) area

André Pugin , *Susan Pullan*
CGC
Contact: Erwan_Gloaguen@ete.inrs.ca

Over the past 2 years we have tested a vibroseis system towing a landstreamer consisting of 3-component geophones mounted on 48 sleds at 0.75 m spacing. Two types of shear waves are observed: SV reflections primarily in in-line (H1) and vertical (V) components, and SH in the cross- line component (H2). SV

waves have been observed to reach frequencies up to 200 Hz or more, significantly higher than the frequency content in the SH mode recorded in the cross-line component. The high frequencies correspond to sub-metre wavelengths in areas where shear wave velocities are very low (e.g. Holocene marine clays from the St Lawrence valley lowlands) allowing very high resolution ultra-shallow seismic reflection observations. On processed SV wave reflection sections from these environments we can observe data quality on land with resolutions comparable to data acquired with high resolution water-borne systems. Moreover, significant P-wave reflection signals are also present in the V component with inline horizontal source orientation. The sequential stratigraphy can be thoroughly analysed in the Richelieu area using more than 50 km of seismic lines of such high resolution data. The sedimentary sequences are usually delimited by erosion surfaces. Detailed seismic facies observations allow the characterisation of till, gravel, sand and mud deposited in systems related with eskers and large subsea fans and are being used for hydrogeological investigations. In the next stage of this research, the calibration of seismic facies using borehole data will allow the recognition of typical aquifer and aquitard lithologies.

Classification, modeling, and inter-comparison studies of environmental controls on catchment hydrologic response / Classification, modélisation et études comparatives des mécanismes de contrôle environnementaux sur la réaction hydrologique des bassins versants

Room / Endroit (Joliet), Chair / Président (Ilja Tromp-van-Meerveld and April James), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D06.1 ID:3912 INVITED/INVITÉ 16:00

Searching for simplicity in complex hydrological and biogeochemical responses: how topographic metrics can be used to track sources, sinks, and their connectivity to surface waters in catchments over broad geographic regions

Irena Creed

University of Western Ontario
Contact: icreed@uwo.ca

Topography is an important factor influencing hydrological patterns and processes within forest regions where runoff generating events are frequent (i.e., with humid climates and shallow soils). The potential of digital terrain analysis for hydrological and biogeochemical applications has been revolutionized by light detection and ranging (LiDAR) technology. Small hydrological features that were previously not detected, particularly in areas where vegetation is dense and the ground is shielded from aerial view, are being mapped with precision previously not possible. Specifically, digital terrain analysis using LiDAR digital elevation models greatly improves the definition of catchment boundaries, the delineation of local depressions that form potentially wet areas, and the identification of ephemeral and permanent streams that connect these features to the stream. I present physically-based topographic metrics for mapping biogeochemical source (and sink) areas and their hydrologic connectivity to surface flow paths, and demonstrate how these metrics can be used to predict runoff generating mechanisms and the associated export of carbon, nitrogen and phosphorus in forested catchments across broad geographic regions.

2D06.2 ID:3348 16:15

Use of available hydrometric data to characterize depressional storage and ever-changing effective drainage areas in North American Prairie watersheds

Eghbal Ehsanzadeh [1], *Chris Spence* [2], *Garth Van Der Kamp* [2]
[1] Postdoctoral Researcher,Environment Canada, National Hydrology Research Centre (NHRC)
[2] Environment Canada, National Hydrology Research Centre (NHRC), Saskatoon, SK Canada S7N 3H5
Contact: eehsanzadeh@gmail.com

We examined the impact of depression storage upon the frequency and magnitude of runoff volume in the glaciated northern interior plains of North America, using a simple statistical approach. In this landscape, the shape of catchment runoff frequency curves reflects the dominant runoff generating mechanisms. These curves can be generated on the basis of many years of available streamflow data. When the predominant runoff process is unaffected by depressions, the shape of the runoff frequency curve resembles the shape of the precipitation frequency curve, allowing for the effects of antecedent soil moisture, infiltration, evaporation, sublimation, and wind redistribution of snow. However, when the runoff response of the watershed is affected by varying thresholds associated with fill and spill through depressions, the shape and slope of frequency curves reflect the number, size, and spatial distribution of depressions and also the antecedent depressional water storage within the gross drainage basin boundaries. A comparison of runoff frequency curves with or without depressions provides a good measure of the amount of water retained by surface depressions without recourse to the detailed topography of the basins. This, in

turn, can be used to estimate the fraction of the drainage area contributing to the outlet runoff given an estimate/prediction of precipitation events. Results obtained from this study provide valuable insights into the complex function of closed and intermittently contributing wetlands and also hydrological processes and particularly runoff response mechanisms in the pothole dominated Prairies of North America.

2D06.3 ID:3675 16:30

Hydrograph shape factor: A robust approach for hydrologic classification.

Michael Wagner , *Uldis Silins*
University of Alberta
Contact: michael.wagner@ualberta.ca

A major challenge of past and recent hydrologic classification work has been selecting among the many possible metrics for use in the delineation of homogeneous hydrologic regions. Regional hydro-climatic classification based on the stream/river discharge of catchments can help reveal unique patterns governed by higher order controls such as climate and physiography, and provide valuable insights on how flow regimes differ across spatial and temporal scales without extensive data requirements. This work explores and tests an approach to classification based solely on the shape of hydrographs with the objective of exploring if shape factor can serve as a simplified, yet robust approach for regional hydrologic classification. Hierarchal cluster analysis of standardized hydrograph shape using long term streamflow records of catchments distributed across the forested landbase of Alberta, Canada demonstrated that the province can be classified into six distinct hydrologic regions. Each region exhibited a unique flow regime (i.e. characteristically unique hydrograph shapes) that reflected the regional variation in hydro-climatic controls dominating streamflow response (physiography, topography, and climate). Further analysis among these regions using specific streamflow variables representative of the overall flow regime including; flow magnitude (mean annual streamflows, flow duration curves, mean maximum and minimum flows); timing of flows (timing of max/min flows, half flow dates), and extreme flows (flood frequency, number and duration of high and low flow events) indicated that the original classification based on shape factor was robust in separating regions of distinct hydrologic behaviour across these more detailed flow parameters. This range of unique flow characteristics reveals further insights into variation of surface water hydrology across Alberta’s forested regions.

2D06.4 ID:3686 16:45

Hydro-climatic controls of streamflow regimes across northern catchments within the North-Watch program.

Sean Carey [1], *Doerthe Tetzlaff* [2], *Jan Seibert* [3], *Jim Buttle* [4], *Hjalmar Laudon* [5], *Jeff Mcdonnell* [6], *Kevin Mcguire* [7], *Chris Soulsby* [2], *Daniel Caissie* [8], *Jamie Shanley* [9]

[1] Carleton University, Canada
[2] Northern Rivers Institute, University of Aberdeen, Scotland
[3] University of Zurich - Irchel, Switzerland
[4] Trent University, Canada
[5] SLU, Sweden
[6] Oregon State University, USA
[7] Virginia Tech, USA
[8] Fisheries and Oceans, Canada
[9] U.S. Geological Survey, USA
Contact: sean_carey@carleton.ca

The boreal/subarctic region of the Northern hemisphere is particularly sensitive to the influence of climate change as small differences in temperature determine the status of frozen ground, precipitation phase, and the magnitude and timing of snow accumulation and melt. An international inter-catchment comparison program North-Watch (http://www.abdn.ac.uk/northwatch/) seeks to improve our understanding of the sensitivity of northern catchments to climate change by examining their hydrological and biochemical responses. The catchments are located in Sweden (Krycklan), Scotland (Mharcaidh, Girnock and Strontian), the United States (Sleepers River, Hubbard Brook and HJ Andrews) and Canada (Catamaran, Dorset and Wolf Creek). An initial stage of the North-Watch program focuses on how these catchments collect, store and release water. At most sites, ten years of daily precipitation, discharge and temperature were compiled and evaporation and storage calculated. Inter-annual and seasonal patterns of hydrological processes were assessed via normalized fluxes and standard flow metrics. At the annual-scale, relations between temperature, precipitation and discharge were compared; highlighting the role of latitude, wetness and frozen ground on streamflow response. The seasonal pattern and synchronicity of fluxes at the monthly scale provided insight into the system memory and the role of storage. While some catchments rapidly translate precipitation into runoff, others exhibit considerable buffering, storing water for release many months after precipitation. The coefficient of variance of monthly fluxes and correlation coefficients were used to characterize the synchronicity and variance of seasonal rainfall-runoff patterns. A principal component analysis revealed clustering among like catchments in terms of functioning, largely controlled by two components that reflect (PC1): i) temperature/precipitation gradients, ii) the correlation between monthly precipitation and discharge, and (PC2) iii) storage, iv) the seasonal variability of precipitation. Results provide a conceptual framework for understanding hydrological change across northern catchments.

2D06.5 ID:3320 17:00

Climate, Streamflow and Groundwater Interactions in the Canadian Cordillera

Diana Allen [1], *<u>Paul Whitfield</u>* [2], *Aurelia Werner* [3]
[1] Department of Earth Sciences, Simon Fraser University, Burnaby, BC
[2] Meteorological Service of Canada, Vancouver, BC

[3] Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC
Contact: paul.whitfield@ec.gc.ca

Long and short-term variations of local precipitation and streamflow are often reflected in groundwater level fluctuations. In this study, groundwater responses in the Canadian Cordillera are assessed using the best available groundwater, hydrometric and climatic data. Well and stream hydrographs are analyzed using a series of diagnostic tools including time series plots, hysteresis plots, and cross-correlation plots. As might be expected, the seasonal timing of aquifer and streamflow responses requires consideration of the hydro-climatology of the region; rainfall-dominated (pluvial), snowmelt-dominated (nival) or hybrid (mixture of rain and snow). The magnitude and timing of the recharge and discharge responses of the groundwater system were shown to depend on the hydrogeology of the aquifer, specifically its storage and permeability characteristics and whether the system is stream-driven or recharge-driven. These two dominant stream-aquifer system types were defined based on classifying different aquifer types found in the southwest portion of the province. The classification scheme and diagnostic tools have the potential to provide a framework for evaluating the responses of wells in other mountainous regions, as well as the potential consequences of future climate change in these varied hydrogeological and hydro-climatic settings.

2D06.6 ID:3874 **17:15**

Proglacial hydrogeology in the Cordillera Blanca, Peru: A hydrologic processes characterisation based on hydrochemical and isotopic measurements

Michel Baraer [1], *Jeffrey Mckenzie* [1], *Bryan Mark* [2]
[1] McGill University
[2] Ohio State University
Contact: michel.baraer@mail.mcgill.ca

Tropical glaciers are rapidly retreating with potentially critical water resource impacts for populations who depend on them. The role of proglacial hydrology in these systems is poorly understood, making the projection of these changes at the watershed scale difficult. In this study we use hydrochemical and isotopic signatures of potential hydrologic sources and surface waters to characterize proglacial hydrogeology at four glacially fed watersheds within the Cordillera Blanca, Peru. Water samples from streams, glacial melt, and groundwater were collected in 2008 and 2009 and analyzed for major ions (e.g., SO42-, Mg2+) and the stable isotopes of water (δ18O and δ2H). We used the Hydrochemical Basin Characterisation Method (HBCM), a multi-component spatial mass-balance technique, to quantify the contribution of end-members to the four watershed outflows. Multivariate variance analysis was used to identify which hydrochemical and isotopic characteristics of the water samples depend primarily on water origins, as opposed to the geophysical characteristics of the valleys. These characteristic variables were then studied using binary diagrams to determine

relative importance and contributions of different components at the regional level. The HBCM results show that melt water and groundwater dominate dry season discharge, and that groundwater specific discharge is above 0.35 mm per day for all of the study valleys, indicating that it is a critical contributor to tropical proglacial hydrologic systems. Results from the binary diagrams are used to develop a conceptual hydrological model where pampa surfaces, large flat areas typical of high valleys in the Cordillera Blanca, are hydrogeologically isolated at the regional scale. Talus and lateral periglacial deposits are identified as dominant aquifers and pathways to surface water.

Climate Change and Extreme Events (Part 1) / Le changement climatique et les évènements extrêmes (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Chad Shouquan Cheng), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D07.1 ID:3481 16:00

Simulated Changes in the Freezing Rain Climatology of North America under Global Warming using the Canadian CGCM3 Climate Model

Steven Lambert [1], *Bjarne Hansen* [2]
[1] Canadian Centre for Climate Modelling and Analysis, Environment Canada
[2] Cloud Physics and Severe Weather Research, Environment Canada
Contact: steve.lambert@ec.gc.ca

Freezing rain episodes are often associated with severe damage and loss of life. Given the disruptive nature of freezing rain, changes in its frequency and geographical distribution are of considerable importance. This question is addressed by applying the precipitation typing algorithm developed by Ramer to climate model simulations. The freezing rain climatology is extracted for two twenty-year periods; 1981-2000 and 2081-2100 using the SRES A2 scenario. The two climatologies will be presented and the differences between them will be discussed.

2D07.2 ID:3971 16:15

Nonlinear statistical downscaling of maximum and minimum temperature. Case study: Vancouver Island, Canada

Carlos Gaitan Ospina [1], *William Hsieh* [1], *Alex Cannon* [2], *Philippe Gachon* [3]
[1] University of British Columbia
[2] University of British Columbia/Environment Canada

[3] Environment Canada
Contact: cgaitan@eos.ubc.ca

The Canadian Coupled Global Climate Model version 3 (CGCM 3.1) using the SRES A2, and A1B emission scenarios (was downscaled using a variety of linear and nonlinear machine learning/statistical methods (e.g. linear regression, principal component analysis, artificial neural networks) to obtain daily station values of maximum temperature (TMAX), and minimum temperature (TMIN) for five weather stations located on Vancouver Island. The downscaled data were analyzed for variability and extremes events, using extreme indices computed from daily values. Comparisons in variability were made between values of these indices observed in the base climate period (1961-2000) with both downscaled runs using CGCM3.1 and reanalysis predictors, and values projected for the 21st century using the two emission scenarios. The results show that the downscaled data series were able to capture higher variances than the NCEP/NCAR Reanalysis and the SRES scenarios, although these variances are smaller than those observed at the weather stations

2D07.3 ID:4005 16:30

Generative Topographic Mapping: a recursive network method used to understand climate variability and change over Southern Quebec.

Andrew Harding [1], *Milka Radojevic* [1], *Philippe Gachon* [2], *Van Tv Nguyen* [1]
[1] Global Environmental and Climate Change Centre, McGill University
[2] Adaptation and Impacts Research Section (AIRS), Climate Research Division, Environment Canada
Contact: andrew.harding@mcgill.ca

Recursive Networks applied to Machine Learning problems have proliferated through a surprising number of fields of study over the last decade, including image recognition, speech recognition, economics, and (as in this case) climatology. Self Organising Maps, Generative Topographic Maps, and Echo State Networks are all relatively new techniques that provide interesting capabilities when applied to physically dynamic systems. Multi-station coherence, Bayesian (probabilistic) output, and even short-term memory are all useful traits when working within frameworks such as statistical downscaling. Here, we present a short history of recent development, and include results to show how advances in the field can be used to study the response of surface climate extremes to larger scale atmospheric circulation through function approximation, how recursive pattern classification can improve upon factor analysis approaches such as Principal Components or Canonical Correlation Analysis, and how future work may offer an approach to the temporal persistence of downscaled time series. Our results are shown over 50 stations in Southern Quebec, using teleconnection indices and more local forcing factors derived from both reanalysis over the current period, and model data for the future.

2D07.4 ID:3787 16:45

Tropical Cyclogenesis Potential in Climate Change: An Application of Artificial Neural Networks

Zheng Ki Yip , *Peter M.k. Yau*
Dept. of Atmospheric & Oceanic Sciences, McGill University
Contact: peter.yau@mcgill.ca

One of the most important consequences of warming climate is the potential change in tropical cyclogenesis. To estimate this change, we use General Circulation Model (GCM) output to obtain changes in Emanuel's revised Genesis Potential Index (GPI) for present and future climate into the 21st century. The GPI is an empirical relation representing the contribution of the following 6 environmental variables to the genesis of tropical cyclones: 850 hPa absolute vorticity, 600 hPa relative humidity, 600 hPa specific humidity at saturation, 600 hPa temperature, 850-200 hPa wind shear, and potential intensity (PI).

The self-organizing map (SOM), a non-linear classifier, is used to classify the monthly Austral Summer GCM output of the six environmental variables into different patterns that dominated the period 1960 to 2099 over the tropical North Atlantic, and to construct corresponding patterns of GPI. The analysis of the SOM results, using the monthly output of the Geophysical Fluid Dynamics Laboratory (GFDL) CM2.0 (IPCC SRES scenario A2) climate model, projected for next century a decrease in tropical cyclogenesis potential in all parts of the North Atlantic basin between 2N to 46N, except for regions along the north coast of Venezuela and Guyana, and the latitude band 5-18N east of 60W where an increase of tropical cyclogenesis potential is predicted. The relative contribution of each environmental variable to the projected trends is determined using the SOM output as input to a forward-feeding back propagation neural network (NEVPROP4). The results indicate the decrease (increase) of vertical wind shear and increase (decrease) of PI are the two major factors that contribute to the increase (decrease) of cyclogenesis potential in the two tropical regions (other parts of the North Atlantic basin). While the changes in vertical shear and PI contribute most significantly to the projected trends, the decrease in 600hPa relative humidity also plays a role in the decrease of cyclogenesis potential in the mid-latitude eastern North Atlantic. The results for other models and the North Pacific basin will also be presented.

2D07.5 ID:4040 17:00

Predictability Of 2009 Ontario Tornado Outbreak

Yongsheng Chen , *Geoffrey Bell*
York University
Contact: yochen@yorku.ca

On 20th August 2009, a series of supercell storms and a squall line developed over Michigan and travelled across Ontario. This complex system spawned 18 tornadoes, setting a new record of number of tornadoes in one event. With F0 to

F2 damages, it also became one of the most destructive and costly tornado events ever in Ontario.

The Weather Research and Forecasting (WRF) model with a resolution of 3-km in a triply-nested domain was utilized to simulate this severe weather event. While the squall line was well resolved in a deterministic forecast, it was also found to be sensitive to the uncertainties in the large-scale background flow as well as the model physics. On-going works are investigating the predictability of this tornado outbreak using a high-resolution ensemble data assimilation and prediction system. Results will be presented in the meeting.

Low-frequency variability and predictability (Part 2) / Variabilité et prévisibilité à basse fréquence (Partie 2)

Room / Endroit (Capitale), Chair / Président (Bin Yu), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D08.1 ID:3574 **16:00**

Tropical-extratropical teleconnection associated with stratospheric quasi-bienniel oscillation

Seok-Woo Son [1], *Hyeong-Seog Kim* [2], *Hai Lin* [3]
[1] McGill University
[2] Seoul National University
[3] Environment Canada
Contact: seok-woo.son@mcgill.ca

The possible impact of stratospheric quasi-bienniel oscillation (QBO) on the tropospheric circulations is examined using the reanalysis data, outgoing long-wave radiation and tropical cyclone track data. It is found that the QBO modulates convective activities over the western North Pacific by changing vertical wind shear in the upper troposphere. Convective activities especially those at around 10N and 150E are enhanced during the westerly phase of the QBO. The resulting heating then influences extratropical circulations by exciting Rossby waves which propagate poleward and eastward. This causes statistically significant response of meteorological variables in remote places such as the west coast of North America. A series of simple model integrations further confirm these findings.

The QBO-induced circulation change has important implications to the tropical cyclone track and low-frequency variability in both the tropics and extratropics. A

significant relationship between the QBO and the interannual variability of the tropical cyclone track is found over the western North Pacific: More tropical cyclones approach the East China sea during the westerly phase than during the easterly phase of the QBO, consistent with the associated low-level circulation change. The possible relationships between the QBO and the interannual variability of the Madden Julian Oscillation (MJO) and the Pacific North American teleconnection (PNA) are also discussed.

2D08.2 ID:3905 16:15

Real-time bias correction of an atmospheric general circulation model

Viatcheslav Kharin , *John Scinocca*
CCCma, Environment Canada, Victoria, B.C.
Contact: slava.kharin@ec.gc.ca

We present a method to reduce climatological model biases in an atmospheric general circulation model (AGCM). The bias reduction is realized by deriving a fixed annual cycle of spatially varying tendencies, which are applied to the right-hand-side of the model's prognostic equations at run time. The seasonally varying bias corrections are constructed from previous multi-year adaptation runs of the AGCM in which its prognostic variables are relaxed towards observational data. The bias correction methodology is used to perform a number of AMIP-type simulations to estimate the effect of bias-correcting tendencies on various aspects of model performance, including climatological annual cycle, intra-annual variability, and monthly-to-seasonal predictability.

2D08.3 ID:3757 16:30

The role of linear interference in the Annular Mode response to extratropical surface forcing

Karen Smith , *Christopher Fletcher* , *Paul Kushner*
University of Toronto
Contact: ksmith@atmosp.physics.utoronto.ca

The classical problem of predicting the atmospheric circulation response to extratropical surface forcing is revisited in the context of the observed connection between autumnal snow cover anomalies over Siberia and wintertime anomalies of the Northern Annular Mode (NAM). Previous work has shown that in general circulation model (GCM) simulations in which autumnal Siberian snow forcing is prescribed, a vertically propagating Rossby wave train is generated that propagates into the stratosphere, drives dynamical stratospheric warming and induces a negative NAM response that couples to the troposphere. Important questions remain regarding the dynamics of the response to this surface cooling. We show that previously unexplained aspects of the evolution of the response in a comprehensive GCM can be explained by examining the time evolution of the phasing, and hence the linear interference, between the Rossby wave response and the background stationary wave. When the wave response and background

wave are in phase, wave activity into the stratosphere is amplified and the zonal mean stratosphere-troposphere NAM response attains a negative tendency; when they are out of phase, wave activity into the stratosphere is attenuated and the NAM response attains a positive tendency. The effects of linear interference are probed further in a simplified GCM, where an imposed lower tropospheric cooling is varied in position, strength, and sign. As in the comprehensive GCM, linear interference strongly influences the response over a realistic range of forcing strengths. The transition from linear to nonlinear behavior is shown to be a simple function of forcing strength.

2D08.4 ID:3870 16:45

The role of linear interference in the Northern Annular Mode response to tropical SST forcing

Christopher Fletcher , *Paul Kushner*
University of Toronto
Contact: chris.fletcher@utoronto.ca

In the northern extratropics, seasonal prediction depends mainly on finding teleconnections linking modes of daily atmospheric variability with persistent sea-surface temperature (SST) anomalies in the Tropics. These links can be maintained for weeks, months or even years by, for example, El Nino/Southern Oscillation (ENSO) episodes or secular warming trends in the tropical Indian Ocean. In this study we provide new insight into the underlying dynamics of wintertime tropical-extratropical teleconnections using a series of atmospheric GCM experiments forced with prescribed (i) warm ENSO and (ii) warm Indian Ocean SST anomalies. The resulting extratropical zonal mean responses have opposite sign: Indian Ocean warming produces a positive Northern Annular Mode (NAM) response, while ENSO warming produces a negative NAM response. Most of this difference can be explained using recently developed linear wave interference arguments. The two forcings are separated by approximately 180-degrees of longitude and their associated Rossby wave responses have opposing projections onto the background stationary waves. Finally, we conduct idealized experiments to demonstrate the importance of the linear interference effects. The Annular Mode response to tropical forcing is significantly weaker in a model with perturbed stationary waves. These results have important implications for our interpretation of teleconnections and thus for seasonal-to-decadal climate prediction.

2D08.5 ID:3994 17:00

Projecting winter-spring climate in Vancouver from antecedent ENSO and PDO signals – Applications to the 2010 Winter Olympics and Paralympics

Ruping Mo [1], *Chris Doyle* [2], *Paul Whitfield* [2]
[1] Coastal & Mountain Meteorology Lab/Pacific Storm Prediction Centre, MSC, EC, Vancouver, BC V6C 3S5
[2] Meteorological Service of Canada, Environment Canada, Vancouver, BC V6C 3S5

Contact: Ruping.Mo@ec.gc.ca

El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) are two important sources of climate variability over North America. The current El Niño event began to emerge along the equatorial Pacific Ocean in May 2009. It reached a moderate-to-strong strength at the end of 2009, and began to weaken in January 2010. Meanwhile, the PDO became near-normal in June-December 2009, and appeared to strengthen toward a positive phase in January 2010. This study focuses on using correlations of the antecedent ENSO and PDO signals with the climatic variables of Vancouver in the following February and March, these being the time of the Vancouver 2010 Olympic and Paralymic Winter Games, to construct predictive models with known skill. Updated on a monthly basis since August 2009 with newly available data, the established models have consistently projected warmer and less-snow conditions in Vancouver through most of the winter-spring season of 2010. More specifically, given the El Niño and PDO conditions up to January 2010, the models suggest that the monthly mean temperature of Metro Vancouver would be 0.9 to 1.2°C above normal in February and 0.5 to 1.1°C above normal in March. The projected precipitation amounts at Vancouver International Airport for February 2010 are in the range of 60–80 mm, with respect to the climatological mean and median of 113 mm and 107 mm, respectively. The projected snowfall amounts for February 2010 are in the range of 0.0–1.3 cm, with respect to the climatological mean and median of 7.9 cm and 1.8 cm, respectively. Validations of these forecasts will be performed at the end of March 2010.

2D08.6 ID:3561 17:15

Seasonal Ensemble-Forecast Experiment Using the Global Environmental Multiscale Model with a Variable Resolution Modeling Approach.

Marko Markovic [1], *Hai Lin* [2], *Katja Winger* [1]
[1]. Department of Earth and Atmospheric Sciences. University of Quebec at Montreal
[2]. Meteorological Research Division, Environment Canada
Contact: markovic@sca.uqam.ca

In this work we evaluate seasonal forecasts performed using the Global Environmental Multiscale model (GEM) in a variable resolution approach with a high-resolution region over different geographical locations. Since the variable resolution approach permits constructing of highly resolved model grid over specific locations, we test two different grid positions, one over North America and the other over the tropical Pacific-eastern Indian Ocean against available observational data and a GEM control run (e.g. uniform grid). With each model configuration, a ten-member ensemble forecast of four months is performed starting from December 1 of selected ENSO winters, between 1982 and 2000. The sea surface temperature (SST) anomaly of the month preceding the forecast (November) is persisted throughout the forecast period. In this study we first analyze variance of interannual variability of external and internal sources in the three GEM configurations. An empirical orthogonal function (EOF) analysis is

performed to identify the dominant patterns of these two sources. Then, various techniques of model skill score verification will be presented to understand the contribution of highly resolved grid location to regional and global seasonal forecast.

The upper troposphere and lower stratosphere (UTLS) (Part 2)/ Haute troposphère et basse stratosphère (HTBS) (Partie 2)

Room / Endroit (Panorama), Chair / Président (Doug Degenstein), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D09.1 ID:3581 **16:00**

Analysis of Transport and Mixing in the Upper Troposphere/Lower Stratosphere Relative to the Jets Using Satellite Data

Gloria Manney [1], *Michaela Hegglin* [2], *William Daffer* [3], *Michelle Santee* [3]
[1] Jet Propulsion Laboratory & New Mexico Tech
[2] University of Toronto
[3] Jet Propulsion Laboratory
Contact: Gloria.L.Manney@jpl.nasa.gov

A method has been developed of characterizing jet structures in the upper troposphere/lower stratosphere (UTLS). We use the characterization of the bottom of the stratospheric polar night jet in the subvortex region and the upper tropospheric jets (including the subtropical jet), along with mixing diagnostics and trajectory calculations, to examine transport and mixing reflected in Aura Microwave Limb Sounder (MLS) and Atmospheric Chemistry Experiment (ACE)trace gas data. Regions of enhanced mixing and transport barriers are related to the characteristics of the UTLS jets. The results are discussed in the light of the different sampling patterns and measurement characteristics of the two satellite instruments.

2D09.2 ID:3705 **16:15**

Residual circulation trajectories and transit times into the extratropical lowermost stratosphere

Thomas Birner
Department of Atmospheric Science, Colorado State University

Contact: thomas@atmos.colostate.edu

Transport into the extratropical lowermost stratosphere (LMS) can be divided into a slow part (time-scale of years) associated with the global-scale residual (Brewer-Dobson) circulation and a fast part (time-scale of days to months) associated with (mostly quasi-horizontal) mixing (i.e. two-way irreversible transport, including stratosphere-troposphere exchange). The Brewer-Dobson circulation can be considered to consist of two branches: a deep branch more strongly associated with planetary waves breaking in the middle to upper stratosphere, and a shallow branch more strongly associated with synoptic-scale waves breaking in the subtropical lower stratosphere. In this study the contribution due to the Brewer-Dobson circulation alone to transport into the LMS is quantified using residual circulation trajectories, i.e. trajectories driven by the residual mean meridional and vertical velocities. This contribution represents the reversible (advective) part of the overall transport into the LMS and can be viewed as providing a background onto which the effect of mixing has to be added. Residual mean velocities are obtained from a comprehensive chemistry-climate model as well as from ECMWF reanalysis data. Residual transit times of air traveling from the tropical tropopause to the LMS along the residual circulation streamfunction are evaluated and compared to mean age of air estimates. A clear time-scale separation with much smaller residual transit times into the mid-latitudinal LMS than into polar LMS is found that is indicative of a clear separation of the shallow from the deep branch of the Brewer-Dobson circulation. In contrast mean age of air exhibits a much more homogeneous latitudinal structure. Nevertheless, the residual transit time distribution reproduces qualitatively the observed seasonal cycle of youngest air in the fall and oldest air in the spring.

2D09.3 ID:3925 16:30

Chemical tracers as indicators of transport time scales and source regions of air in the UTLS

Eric Ray , *Fred Moore* , *Karen Rosenlof* , *James Elkins* , *Geoff Dutton* , *Brad Hall* , *Dale Hurst* , *David Nance*
NOAA/ESRL
Contact: eric.ray@noaa.gov

The UTLS is a complex mixture of air transported from a variety of different regions and over a wide range of time scales. This can make the interpretation of tracer distributions in the UTLS quite difficult. We present a method to use measurements of molecules with photolytic processing in the stratosphere to quantitatively estimate the stratospheric ‘overworld’ contribution to UTLS tracer gradients. With this information the ‘age’ tracers, such as CO2 and SF6, can reveal transport time scales and surface latitudinal origins of UTLS air. We demonstrate these techniques with observations from the START-08 and HIPPO aircraft campaigns, which are uniquely suited to this type of study. Implications of our results for modeling of important greenhouse gases in the troposphere will be

discussed.

2D09.4 ID:3852 16:45

Lidar observations of volcanic aerosols in the UTLS region

Thomas Duck [1], *Lubna Bitar* [1], *Nina Kristiansen* [2], *Andreas Stohl* [2], *Steve Beauchamp* [3]
[1] Department of Physics and Atmospheric Science, Dalhousie University
[2] Norwegian Institute for Air Research (NILU)
[3] Meteorological Service of Canada
Contact: tom.duck@dal.ca

Aerosols from the Kasatochi Volcano eruption on 7-8 August 2008 were observed with the Dalhousie Raman Lidar in the troposphere and lower stratosphere above Halifax, Nova Scotia. The first detections occurred one week after the eruption, and continued for the next four months thereafter. The plume was tracked back to the volcano using the FLEXPART Lagrangian particle transport model. The stratospheric plume descended at a rate of 47.1 +/- 2.8 m/s, corresponding to a cooling rate of 0.60 +/- 0.07 K/day. Surprisingly, the tropopause descended at the same rate on average over the four month period. The top of the plume maintained a steady upper altitude of 18 km, and the bottom was at the tropopause. It is likely that the stratospheric plume provided a source for upper tropospheric aerosols for several months. The optical depth of the plume was relatively constant at 0.003 for 532 nm wavelength. The lidar data were consistent with similar measurements from OSIRIS, and provide an interesting picture of UTLS transport and mixing processes.

2D09.5 ID:4056 17:00

High-Resolution Measurements of Stratosphere-Troposphere Exchange Using Radar Windprofilers and Balloon-Borne Ozonesondes

David Tarasick [1], *Trevor Carey-Smith* [2], *Wayne Hocking* [3], *Huixia He* [1], *Mohammed Osman* [3], *Stephen Argall* [3]
[1] Environment Canada
[2] National Institute of Water and Atmospheric Research, New Zealand
[3] University of Western Ontario
Contact: david.tarasick@ec.gc.ca

Twice-daily ozonesondes have been launched during a number of short campaigns, incorporating nearby radar windprofiler measurements, in Ontario and Quebec between 2005 and 2009. This novel combination of observations has demonstrated the existence of a strong relationship between apparent rapid changes in tropopause height and stratosphere-troposphere exchange (STE). In general, stratospheric intrusions appear to follow the passage of upper level cyclones which temporarily force the mid-latitude jet stream south of the observing locations. Since total ozone variations at extratropical latitudes are well-correlated with synoptic scale meteorological disturbances, particularly

tropopause height, this suggests that it may be possible to relate rapid changes in total ozone to the occurrence of ozone intrusions. Further examination shows that where the radar- determined tropopause differs from the WMO thermal tropopause, the radar is typically responding to the sharp gradients of potential temperature and humidity at the lower edge of a stratospheric intrusion. Radar appears to be a particularly good intrusion detector. In addition to explaining the radar's success at finding STE events, this fact can potentially be used to study the descent of layers of stratospheric origin in the troposphere.

2D09.6 ID:3441 17:15

Deep Stratospheric Intrusions During the August 2006 IONS Campaign

Michel Bourqui [1], *Pier-Yves Trépanier* [2]
[1] McGill University
[2] Université de Montréal
Contact: michel.bourqui@mcgill.ca

Stratosphere-to-troposphere transport (STT) is a key process affecting the ozone budget and variability in the troposphere. Recent studies have suggested that deep STT events reaching the lower troposphere within time scales of a few days may have a significant incidence. Such events may bring very high concentrations of ozone to the planetary boundary layer, raising the "background" ozone level, and thereby enhancing man-made ozone pollution events. However, current knowledge on such events is weak. In particular, details of the dynamics of the descent and the extent of dilution with tropospheric air before reaching the lower troposphere are unknown.

In this study, we use the Global Environmental Multiscale (GEM) mesoscale model in the limited area mode and calculate kinematic trajectories to detect and analyse deep STT events. The period of investigation is August 2006, as ozone sonde measurements were made within the IONS campaign. The analysis shows that the descents stay very compact, undergoing almost no mixing with surrounding air, until the 700hPa isobar is reached. The total amount of stratospheric mass injected below this level during the period of investigation is much larger than could be expected from previous studies.

Seismic Microzonation / Microzonage sismique

Room / Endroit (Pinnacle), Chair / Président (Dariush Motazedian), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D10.1 ID:3958 INVITED/INVITÉ 16:00

Earthquake Site Response Studies in Canada: Past, Present, and Future

John Cassidy
Geological Survey of Canada
Contact: jcassidy@nrcan.gc.ca

More than 75% of Canada's population lives in urban centres. Many of the these centres, including Vancouver, Montreal, Ottawa, Victoria, and Quebec City, are located in seismically active regions. Large earthquakes around the world, including 1995 Kobe, 1985 Mexico City, and 1994 Northridge, have clearly demonstrated a significant variation in shaking across an urban area. Ground shaking is altered by surficial geology, basin structure (both shallow and deep), resonance effects, and bedrock topography. Amplification factors of ten or greater (relative to bedrock) have been observed, and the variation in shaking clearly contributes to the observed damage patterns (both the amount of damage, and the type of building stock that is impacted). In Canada, large earthquakes have also shown the importance of local site effects. For example, damage patterns from the 1944 M 5.6 Cornwall earthquake and the 1988 M 5.9 Saguenay earthquake showed enhanced damage on the soft Leda clays along the St. Lawrence and Ottawa Valleys. Damage in Victoria, BC from the M 7.3 central Vancouver Island earthquake of 1946 (200 km distant) was largely concentrated in areas of soft clay pockets and old peat bogs. One of the first attempts at seismic microzonation in Canada was based on local geology and the observed effects of the 1946 earthquake in Victoria. In recent years, significant advances in geological and geotechnical mapping techniques (e.g., detailed results from seismic reflection/refraction), combined with larger seismic data sets (including weak, and strong ground shaking, as well as ambient noise recordings) have contributed to an improved understanding of various site effects. In this presentation, I summarise some of the past and present earthquake site response studies in urban areas of Canada, and outline some recent advances (as well as some of the challenges) in this field that will help reduce losses from future earthquakes.

2D10.2 ID:4172 INVITED/INVITÉ 16:30

Seismic microzonation – the perspective of Canada's insurance industry

Paul Kovacs
ICLR
Contact: pkovacs@iclr.org

It is inevitable that a major earthquake will strike a large urban centre in Canada. Thousands of people may die and there may be tens of billions of dollars of property damage and economic losses. Insurance is one of the tools Canadians use to manage seismic risk. Indeed, most businesses in Canada and most homeowners in British Columbia purchase earthquake insurance coverage.

Microzonation research provides an important foundation for better understanding and management of this risk by insurers and others. Microzonation studies support 1) better insurance pricing decisions; 2) better use of reinsurance; and 3) insurance efforts to promote mitigation. The objective of insurance is to align the price of coverage with the risk of loss for a specific building, and microzonation studies provide information that provides more detailed assessment of the risk of damage at a particular location. Insurance companies in Canada also purchase several hundred million dollars of reinsurance each year to transfer part of their exposure to international markets, and better knowledge about seismic risk will enhance the use of reinsurance by insurance companies. Also insurance companies have a long tradition of promoting loss prevention, and microzonation studies have the potential to better direct and support insurance efforts to champion seismic risk reduction, such as the sharing of safety advice with policyholders with higher risk.

2D10.3 ID:3974 16:45

Advances in Seismic Hazard Assessment within the Ottawa Area Leda Clays

Heather Crow [1], *James Hunter* [2], *Dariush Motazedian* [3], *Andre Pugin* [2]
[1] Carleton University, Geological Survey of Canada
[2] Geological Survey of Canada
[3] Carleton University
Contact: hcrow@connect.carleton.ca

New seismic guidelines for construction were recommended in the 2005 National Building Code of Canada (2005NBCC). Horizontal shearing forces at ground surface from the design earthquake are based in part on the geotechnical/geophysical properties of the near surface at a building site. The Geological Survey of Canada (GSC) and Carleton University have undertaken a multi-year research project in the Ottawa area to investigate some of the parameters addressed in the 2005 NBCC. Among map product outputs, a number of related research projects were carried out and are discussed herein.

Recent research by the GSC has focused on the design of a landstreamer coupled with a variable swept-frequency vibratory source to collect P- and S-wave seismic reflection data. For Ottawa area hazard studies, landstreamer lines were selected where thick (>30m) Champlain Sea sediments were known to exist over complex bedrock topography. These results allowed for the shear wave velocity structure of the overburden to be contoured with large degree of accuracy along the profile alignment.

Also carried out was a comparison of the 2005NBCC fundamental site period equation (4H/Vs) to the horizontal-to-vertical spectral ratio (HVSR) technique using a Tromino instrument at 185 sites across Ottawa and outlying areas. A comparative plot of the site periods computed by both approaches shows that a systematic variation occurs between the 4H/Vs estimates and the HVSR

measurements. At long periods (1.5-2.5 seconds) the deviation between the two methods reaches 30-40%.

Unusually high amplification ratios have been recently measured in Leda Clays at low levels of earthquake-induced ground shaking. As the effect of seismic Q, or damping (D=1/2Q), on ground motion at soft soil sites in Ottawa is not well understood, small-strain attenuation measurements have been carried out in situ and in the lab. Analysis of the data yield small strain Q's of ~140 (or damping of ~0.4%). Resonant column (RC) tests to measure material damping in the lab yield values of 1.0%-1.8% at strain levels ranging from 10E-6 to 10E-5%.

2D10.4 ID:3915 17:00

Site response analysis for the city of Ottawa using finite element method

Kasgin Khaheshi Banab , *Dariush Motazedian* , *Siva Sivathayalan*
Carleton University
Contact: kkbanab@connect.carleton.ca

A comprehensive site response analysis was carried out for the city of Ottawa using the one-dimensional finite element method (FEM). This research was concentrated in three major phases: First, using FEM, the weak motion amplification ratios (AR) were obtained for deep sites located in the eastern part of the city and the results were compared against the amplification ratios from the recorded weak motions. The outcomes exhibited good agreement between the peak AR values from the modeling and the observations. Second, the combined effect of soil-bedrock contrast ratio and the shaking intensity on the variation of peak AR values was examined. As a representative model of the mentioned combined effect, a logarithmic-exponential function was proposed and validated against a variety of acceleration input motions. Third, low and high frequency AR values were extracted for the variety of the site categories throughout the city. These AR values were correlated to some indicator parameters. These parameters include the average shear wave velocity in top thirty meter of soil profiles and the fundamental frequencies of the studied sites and/or the dominant frequencies of input motions.

2D10.5 ID:3731 17:15

Site resonance study in a valley environment with single station HVSR and array based SPAC microtremor survey methods: The Tamar Valley, Launceston, Australia

Maxime Claprood [1], *Michael Asten* [2], *Jozef Kristek* [3]
[1] CEGAS, Monash University, Melbourne, Australia. Now with: Centre ETE, INRS, Québec, Canada
[2] CEGAS, Monash University, Melbourne, Australia
[3] Faculty of Mathematics, Comenius University Bratislava, Slovak Republic
Contact: Maxime.Claprood@ete.inrs.ca

The recording of ambient seismic vibrations (microtremors) is a valuable alternative to traditional active seismic methods and strong ground motion analysis when evaluating the velocity structure and pattern of resonance during site resonance studies. Microtremor observations are interpreted with the spatially averaged coherency spectra (SPAC) method to evaluate the shear wave velocity (SWV) profiles at 10 separate sites in Launceston, Australia. The SWV profiles show great variability within the city limits: the depth to bedrock interface varying from 0 m to 250 m within a few kilometres. The Tamar Rift Valley is thought to induce an intricate pattern of resonance across the city. The rapid variations in geology in Launceston violate a fundamental assumption required for the interpretation of SPAC microtremor observations: that the geology can be approximated by a layered earth. Conventionally, the SPAC method involves recording coherency spectra between pairs of vertical-component sensors azimuthally distributed around a centre sensor. The spatially averaged coherency spectra computed for available inter-station separations are then inverted for the soil SWV profile. The reliability of the coherency spectra recorded within the Tamar Valley in Launceston is experimentally assessed by decomposing the spatially averaged coherency spectrum into coherency spectra recorded from pairs of sensors with varying azimuth. SPAC observations are recorded in the Tamar Valley to evaluate SWV profiles and complete a site resonance study of the Tamar Valley with single station HVSR observations recorded along two profiles transverse to the valley axis. Numerical simulations of the propagation of surface waves in a 2D model representation of the Tamar Valley agree well with SPAC and HVSR observations in Launceston, and demonstrate the potential of the methods to conduct site resonance studies in a valley environment.

Physical-Biological Interactions in the Aquatic Environments / Interactions physiques et biologiques dans les environnements aquatiques

Room / Endroit (York), Chair / Président (Tetjana Ross), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D12.1 ID:3371 INVITED/INVITÉ 16:00

Link between benthic macroinvertebrate diversity and the hydrology of High Arctic ponds

Alison Croft , *Kathy L. Young*

York University
Contact: alison_croft@hotmail.com

This hydroecological study examined how temporal changes in High Arctic pond water regimes impact benthic macroinvertebrate (BMI) communities (e.g. diversity). Here, we compare BMI communities in three hydrologic pond regimes (stable, fluctuating and ephemeral). The study took place at Polar Bear Pass (PBP), Bathurst Island (Lat. Long.) and Cape Bounty (CB), Melville Island (Lat., Long), Nunavut from early May to September, 2009. These islands have contrasting climatic regimes and geology. At both sites, snowcover and melt were estimated using standard approaches. During the post-snowmelt period regular frost and water table measurements of ponds allowed the seasonal hydrologic regimes to be documented. BMI were collected throughout the summer months following a standardized protocol, which included three transects from pond edges. Water quality variables were also monitored (e.g. pH, temperature, dissolved oxygen, conductivity, salinity and light). Preliminary results indicate that the unusually wet year in 2009 (ca. 96 mm of rainfall) impacted the hydrological regime of these ponds. The isolated “ephemeral” pond did not dry out, and instead the water table fluctuated in response to seasonal drying and wetting episodes. Water tables in both the “fluctuating” pond and the “stable” pond remained relatively steady throughout the season due to frequent inputs of rain and runoff from multiple sources of water. Generally, the ponds had similar benthic macroinvertebrate families and low diversity as measured by the Shannon-Weaver index. Most ponds decreased in diversity from June to August with the exception of fluctuating ponds. Ephemeral ponds had a higher level of diversity compared to stable and fluctuating ponds. Despite the wet season, results suggest a weak link between the diversity of benthic macroinvertebrates and the hydrological regime of High Arctic ponds.

2D12.2 ID:3383 16:30

Coupling of Nutrient-Phytoplankton-Zooplankton (NPZ) Models to internal wave dynamics in lakes.

Anton Baglaenko , *Marek Stastna* , *Francis Poulin* , *Derek Steinmoeller*
University of Waterloo
Contact: abaglaen@uwaterloo.ca

Nutrient (and consequently plankton) patchiness effects the entire aquatic ecosystem. Theories of plankton patchiness are varied, but many relate to coherent features of the fluid dynamics (e.g. eddies). In this talk Phytoplankton-Zooplankton (PZ) and Nutrient-Phytoplankton-Zooplankton (NPZ) models are examined utilizing one and two-layer shallow water weakly nonhydrostatic models that allow us to accurately resolve both large and small scale motions (including internal solitary waves) . Effects of diurnal migrations are modeled in 2-layer models, as are the effects of nutrient sources due to wave-induced sediment resuspension. In oligotrophic lakes sediment resuspension may be a controlling factor in nutrient supply, and hence on the entire NPZ system.

2D12.3 ID:3350 16:45

Interdisciplinary Oceanographic Observations of Orphan Knoll

Blair Greenan , *Igor Yashayaev* , *Bill Li* , *Erica Head* , *Glen Harrison* , *John Loder* , *Kumiko Azetsu-Scott*
Bedford Institute of Oceanography
Contact: blair.greenan@dfo-mpo.gc.ca

Orphan Knoll is a seamount which rises to 1800 m at the outer edge of Orphan Basin off the Northeast Newfoundland Shelf. It is located in the equatorward western boundary flow of the North Atlantic's subpolar gyre, and also within 100km of the subtropical North Atlantic Current's meander towards the Labrador Sea. As a result, there are competing influences on its oceanography from these contrasting large-scale current systems, and from its local topography. Fisheries and Oceans Canada is investigating the degrees of connectivity with, and isolation from, similar marine habitats in the NW Atlantic, for input to international governance decisions. Initial results will be presented, based on a dedicated physical-chemical-biological surveys of the Knoll in May 2008-2010, hydrographic sections across Orphan Basin extending to Orphan Knoll, and other available data. The latter include temperature-salinity profiles and drift trajectories from Argo floats, and satellite altimetry, ocean colour and surface temperature datasets. The results suggest strong connectivity with waters exiting the Labrador Sea, a tendency for clockwise circulation around the Knoll, and some degree of enhanced retention.

2D12.4 ID:3838 17:00

Modeling plankton dynamics in the Strait of Georgia and Juan de Fuca Strait.

Angelica Pena , *Diane Masson*
Institute of Ocean Sciences, Fisheries & Oceans Canada
Contact: Angelica.Pena@dfo-mpo.gc.ca

The Strait of Georgia is a highly productive, semi-enclosed sea with strong estuarine circulation connected to the North Pacific by the Juan de Fuca Strait. In order to better understand the key links between physical and biological processes determining lower trophic level and to predict plausible ecosystem changes, a coupled plankton/circulation models (ROMS-Regional Ocean Modeling System) has been developed. The biological model includes two size classes of phytoplankton and zooplankton, nitrate, ammonia and silicate. Model results from simulations of the mean annual cycle will be presented. In the Strait of Georgia, modeled phytoplankton biomass is higher and more variable than in the Juan de Fuca Strait and show pronounced seasonal variability consistent with observations. In the model, physical variability plays an important role in maintaining the high spatio- temporal variability of plankton abundance. In particular, the influence of fresh water inputs, tidal mixing and wind events on

phytoplankton production and biogeochemical cycles is discussed.

2D12.5 ID:3502 **17:15**

Climate-driven chlorophyll-a variability in the southern Beaufort Sea from 1997 to 2009

Shilin Tang [1], *Christine Michel* [1], *Pierre Larouche* [2]
[1] Freshwater Institute, Fisheries and Oceans Canada
[2] Institut Maurice-Lamontagne, Fisheries and Oceans Canada
Contact: Shilin.Tang@dfo-mpo.gc.ca

Due to the combination of many forcings, such as the seasonal presence of ice, a pronounced light regime, varying sea surface temperatures and a large terrestrial freshwater runoff, the marine ecosystem in the southern Beaufort Sea is very complex. To better understand the coupling between the physical forcings and the phytoplankton biological response, we analyzed surface chlorophyll a (chl a) concentration using SeaWiFS data from 1997 to 2009. Results from an empirical orthogonal function (EOF) analysis showed that three main modes explained 75% of the variability. The first EOF mode showed positive chl a anomalies throughout the Beaufort Sea with maximum values in the northern part of the study area. This mode was highly correlated with the Multivariate ENSO Index (MEI). The sea surface temperature (SST) was found to be the main contributor to the first EOF mode. The second mode showed contrasting chl a anomalies in the eastern and western sectors of the study area, likely explained by upwelling processes. Finally, the third mode showed that the chl a concentration is also influenced by the Mackenzie River flow.

August 20th 2009 Ontario Tornado Outbreak / Éruption de tornades du 20 août 2009 en Ontario

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Isabel Ruddick), Date (02/06/2010), Time / Heure (16:00 - 17:30)

2D14.1 ID:3327 **16:00**

August 20th 2009 – The day the skies rained tornadoes

Arnold Ashton [1], *Mike Leduc* [1], *Sudesh Boodoo* [2]
[1] Environment Canada
[2] Cloud Physics and Severe Weather Research Section, Environment Canada
Contact: arnold.ashton@ec.gc.ca

On August 20 2009 between 3:30 and 10:00 PM EDT, 18 tornadoes were reported in Southern Ontario within 250 km north of a west-east line through the city of Toronto. This is the largest number of tornadoes in a single outbreak ever recorded in Canada. Four of these storms attained F2 intensity. One fatality was reported, and damage claims were in the tens of millions of dollars. We will map the outbreak and discuss many of the unusual aspects of the event, as well as include a wide collection of photos. One particular aspect of the storms that will be explored in some detail is the passage of four supercells that moved along a line (possibly a lake breeze) through the densely populated suburbs north of Toronto between 5 and 7 PM EDT, causing two F2 and one F1 tornadoes. Evidence, including eyewitness accounts, innumerable videos, and radar outputs (King City and Buffalo reflectivity and Doppler data, and King City polarimetric data) will be assessed. This data leads to an unusual and surprising conclusion to the sequence of tornado touchdowns in the Toronto suburbs.

2D14.2 ID:3960 16:15

Damage Observations from the Two Tornadoes in Vaughan Ontario on August 20, 2009

Gregory Kopp , *Murray Morrison* , *Eri Gavanski* , *Craig Miller*
(Presented by *Craig Miller*)
University of Western Ontario
Contact: gak@blwtl.uwo.ca

The results of a detailed damage investigation of the two tornadoes in Vaughan, Ontario, which were part of the outbreak of 18 tornadoes on August 20, 2009, are presented. The bulk of the damage in both tornadoes consisted of structural roof failures categorized as F1 on the Fujita Scale and EF1 on the Enhanced Fujita Scale. However, multiple houses in both tornadoes suffered total roof failure, which is F2 (or EF2). It was observed that the total roof failures were all due to either internal pressurization and/or weak (or non-existent) roof-to-wall connections. Since internal pressures are likely to be significantly larger than external pressures for these single family residences, it is argued that the total roof failure occurred under wind speed conditions associated with a lower degree of damage, such that actual wind speeds are more like those in EF1.

2D14.3 ID:3328 16:30

The August 20th 2009 tornado outbreak: synoptic overview and morphology of the event

Arnold Ashton , *Mike Leduc* , *Mark Firmin*
Environment Canada
Contact: arnold.ashton@ec.gc.ca

The development of severe weather on Aug 20 2009 across southern Ontario was not unexpected. We will present composite charts and weather discussions of the synoptic situation as it developed from T-24 hours to the time of the

outbreak. However, the number of supercells and the percentage of them that became tornadic were historic for Canada and the evolution of this event was rather unique. We will demonstrate this with composite radar imagery.

"Traditional" numerical model guidance did provide some advanced clues to the significance of this tornado outbreak although they also presented some conflicting signals. Studies have shown that higher resolution model output is required to better forecast the spatial and temporal characteristics of severe thunderstorms. In particular, mesoscale model outputs of fields related to buoyant energy and shear have been shown to be very useful in severe storm prediction. These will be introduced as they relate to tornadic storm forecasting versus more linear, non-tornadic storms. A more thorough examination of these fields as they relate to August 20th 2009 will follow in the presentation, “Challenges of Forecasting an Extreme Event”.

2D14.4 ID:3329 16:45

The August 20th 2009 tornado outbreak: challenges of forecasting an extreme event

Arnold Ashton , *Mike Leduc*
Environment Canada
Contact: arnold.ashton@ec.gc.ca

A number of severe weather parameters introduced in the previous talk, “Synoptic Overview and Morphology of the Event”, will be assessed in some detail for the August 20th tornado outbreak. For comparison purposes, the results will be evaluated against a few of the more severe weather events of recent years in Ontario. These comparative events will equally include tornadic outbreaks and well-organized linear storms associated with damaging straight-line winds. One of the results indicates the severe weather parameter DCAPE shows some promise as a discriminator between outbreak types.

Finally, the results will be summarized and linked to a recent study to suggest a philosophy of improving skill in forecasting significant severe weather outbreaks, and even differentiating storm mode. This is crucial for bolstering early preparedness for all stakeholders including emergency management prior to an event as well as improving lead-times for warnings once storms develop.

2D14.5 ID:3330 17:00

Examination of the low level polarimetric radar parameters associated with the Aug 20 2009 southern Ontario tornadic supercells

Michael Leduc , *Sudesh Boodoo*
Environment Canada Cloud Physics and Severe Weather research Section
Contact: ledmike@gmail.com

On Aug 20 2009 numerous supercells with strong rotations moved through southern Ontario. During the period from 2100 to 2230Z 6 of these storms were observed within 60 km of the King City radar. After an exhaustive investigation, it was concluded that 4 of these supercells produced F1/F2 tornadoes while the other 2 did not. This paper will examine the structure of these 6 storms. Twelve other tornadoes were reported in southern Ontario on August 20 but will not be considered here. . The Environment Canada King City 5 cm radar has had dual polarization capability since 2004. The Aug 20 2009 outbreak provides a unique opportunity to study supercell storms at close range. This paper will concentrate on the data from a research mode high resolution 0.5 degree scan collected by King Radar every 10 minutes. For our 6 close- in storms this scan elevation will give a view of the lowest parts of the storm from a few hundred metres to 1 km above the ground. Polarimetric parameters at lower resolution are collected for the full volume scan but will not be presented here. A few papers within the last couple of years have expanded the conceptual models of supercells to include polarimetric parameters. Many of the new features of this conceptual model are observed at low levels. The zdr arc and kdp foot signatures at low levels of the storm will be reviewed here and we will examine how our supercells match this model. A study of the May 2003 Oklahoma tornadic supercell exhibited an expansion and a storm relative clockwise rotation of the kdp foot at low levels as the tornado touched down. Other studies suggest that the polarimetric characteristics of the hook echo may be important in predicting whether a tornado will touch down or not. This study is very preliminary. Previous case studies are nearly all based on 10 cm radar data. A direct comparison with our storms viewed on 5 cm is fraught with difficulties.

2D14.6 ID:3624 17:15

An improved mesocyclone detection algorithm for C-band radars

David Patrick
Hydrometeorology and Arctic Laboratory, Environment Canada
Contact: dave.patrick@ec.gc.ca

A mesocyclone is a thunderstorm-scale circulation that is the parent to most tornadoes, including all of the most destructive tornadoes. While it is rare to detect a tornado with a fixed radar network due to the tornado’s relatively small size and distance from the radar, it is possible to see the larger mesocyclone circulation. The Meteorological Service of Canada mesocyclone algorithm examines single pulse rate frequency radar velocities, noting contiguous areas of gate-to-gate azimuthal shear that exceed a given threshold. A new algorithm has been devised that uses the complete dual pulse rate frequency radar velocity dataset, unfolds the velocities using its own scheme, and smoothes the data to eliminate high frequency noise. For each radar bin, the mean azimuthal shear is calculated for various radii about the bin, using a linear least-squares method. The maximum azimuthal shear and its corresponding radius are saved. This approach can allow for missing radar data, as long as a minimum percentage of valid data is present. Contiguous areas of azimuthal shear that exceed a given threshold are then identified as mesocyclones. The performance of the new algorithm has been evaluated for a number of cases, including the August 20th 2009 Southern Ontario tornado outbreak, and the results are presented. The algorithm shows improved detection of mesocyclones in areas of incomplete data, as well as a reduced false alarm rate.

Plenary PUBLIC LECTURE / Plénière CONFÉRENCE PUBLIQUE

Room / Endroit (Ballrooms ABC), Chair / Président (J.C. Falkingham), Date (02/06/2010), Time / Heure (20:00 - 21:30)

PL.1 ID:4478 INVITED/INVITÉ 20:00

Our Melting Poles: Where Life on Earth is Changing

Warwick Vincent
Université Laval
Contact:

Professor Warwick F. Vincent is an internationally distinguished scientist who studies how life at the base of aquatic food webs responds to environmental change. Originally from New Zealand, he and his family arrived in Québec City almost 20 years ago. He now holds the Canada Research Chair in Aquatic Ecosystem Studies at Université Laval and is Director of the inter-university research and training institute, Centre d'études nordiques (CEN: Centre for Northern Studies), also based at Université Laval. A past president of Canada's National Antarctic Committee, a founding member of ArcticNet and recent group chair of NSERC's grant selection committees in the environmental sciences, he has earned numerous honours for his contributions to research and education. These awards include the Canadian Rigler Prize in Limnology, the New Zealand Gold Medal in Science, and the Royal Society of Canada's Miroslaw Romanowski Medal for achievements in environmental research.

Plenary Day 3 / Plénière jour 3

Room / Endroit (Ballrooms ABC), Chair / Président (Bill Crawford and Spiros Pagiatakis), Date (03/06/2010), Time / Heure (08:30 - 10:00)

P3.1 ID:4304 INVITED/INVITÉ 08:30

Our Earth, Our Future Arctic: Paleolimnological Perspectives Onwards

Marianne Douglas
University of Alberta
Contact: marianne.douglas@ualberta.ca

The Arctic environment is changing rapidly as a direct result of cryosphere-climate interactions as well as human activities ongoing at more southern latitudes. The consequence of this polar amplification has affected the rate of climate change under natural and anthropogenic climate forcing. Future projections for the Arctic identify significant changes within the next century. Contaminants released into the environment at lower latitudes are being deposited at Arctic latitudes and entering the food chain. Documentation and assessment of change needs to be placed in context of baseline conditions or natural variation before the rate and extent of change can be measured. Combined limnological and paleolimnological techniques are common methods used to track and reconstruct past terrestrial environments. These generated data can be compared to model projections to assess the degree of fit. For example, changes in the length of the growing season have already surpassed projected estimates. What are the implications for these changes? Decreases in minimum sea ice extent, increased ease of shipping and access to natural resources for development and increased rates of permafrost degradation are resulting in new conditions in which northern communities especially will have to adapt. New engineering designs and approaches need to be based upon knowledge of the projected environmental changes. It is important for future science and technological developments to be tightly linked with Arctic science and policy developments that are tuned into the reality of rapidly shifting Arctic environmental conditions.

P3.2 ID:4131 INVITED/INVITÉ 09:15

Ocean Acidification: The Other CO_2 Problem

Richard Feely
Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration
Contact: Richard.A.Feely@noaa.gov

Carbon dioxide (CO_2) is one of the most important “green-house” gases in the atmosphere affecting the radiative heat balance of the earth. As a direct result of the industrial and agricultural activities of humans over the past two centuries, atmospheric CO_2 concentrations have increased more than 100 ppm. The atmospheric concentration of CO_2 is now higher than experienced on Earth for at least the last 800,000 years, and is expected to continue to rise, leading to significant temperature increases in the atmosphere and oceans by the end of this century. The global oceans are the largest natural long-term reservoir for this excess CO_2, absorbing approximately 30% of the anthropogenic carbon released into the atmosphere since the beginning of the industrial era. Recent studies have demonstrated that both the temperature increases and the increased concentrations of CO_2 in the oceans are causing significant changes in marine ecosystems. Many marine organisms are already affected by these anthropogenic stresses, including impacts due to ocean acidification. Dr. Feely will discuss the present and future implications of increased CO_2 levels on the health of our ocean ecosystems and related ocean-based economies.

Regional Climate Modelling (Part 1) / Modélisation régionale du climat (Partie 1)

Room / Endroit (Ballroom A), Chair / Président (J.P.R. Laprise), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B01.1 ID:4174 INVITED/INVITÉ 10:30

Weighting models based on several RCM specific metrics: Exploring the concept

Jens Christensen [1], *Filippo Giorgi* [2], *Markku Rummukainen* [3]
[1] Danish Meteorological Institute
[2] Abdus Salam International Centre for Theoretical Physics
[3] Swedish Meteorological and Hydrological Institute
Contact: jhc@dmi.dk

An important new development within the European FP6 project ENSEMBLES has been to explore performance-based weighting of regional climate models. Until now, while no weighting has been applied in multi-RCM analyses, one could claim that an assumption of “equal weight” has implicitly applied. At the same time, it is evident that different RCMs give results of a varying degree of realism, e.g. related to extremes. It is not straightforward to construct, assign and combine metrics of model performance. Rather, there is a considerable degree of subjectivity both to the definition of the metrics and to the way these are combined into weights. This does not mean that weighting, however exploratory, would not be meaningful. Rather, it stresses that the assumptions and choices behind the weights need to be recognized and taken into account. Here we discuss the applicability of combining a set of six specifically designed RCM weights to produce one model index producing combined climate change information from the range of RCMs used within ENSEMBLES. Furthermore, the ‘added value’ from down scaling climate change simulations using an ensemble of RCMs will be addressed in the view of the specific weightings adopted.

3B01.2 ID:3839 10:45

Lessons learned from uncertainty studies applied to RCMs standard diagnostics

<u>Hélène Côté</u> , *Ramon De Elia*
Ouranos
Contact: cote.helene@ouranos.ca

For the past years, sensitivity studies have provided a useful framework to explore different sources of uncertainty affecting climate simulations and projections. Many of these studies have relied on ensembles of global or regional climate simulations specifically designed for various applications and have led to the emergence of concepts like internal variability (IV) and inter- model spread (IMS). These new concepts, as well as more traditional ones such as natural variability (NV), are linked to specific characteristics of models and the climate system and can be used as thresholds against which model modifications can be tested.

All modeling groups face similar challenges when judging the impact and relevance of any change made in the model formulation or configuration. This is particularly true for regional climate models (RCM) –especially those using the Limited Area Model (LAM) approach. For these RCMs, not only the model formulation but also the plentiful choices of configurations (e.g. grid size, grid location, choice of driving data, nesting technique) affect the simulated climate and consequently introduce additional sources of uncertainty. In this context, any regional climate model output diagnostic can strongly benefit from lessons learned through sensitivity studies.

With the help of Ouranos simulated climate datasets, this presentation will illustrate how the use of different aspects of uncertainty like IV, NV or IMS can be fundamental tools for regional climate simulation analysis by increasing the quantitative basis for decision making in RCM evaluation. A central aim of this talk will be to highlight aspects that will help to reduce the potential for inconclusive results or unwarranted conclusions.

3B01.3 ID:3546 11:00

Impacts of the McICA method on cloud-radiation interactions in the Canadian Regional Climate Model GEM-LAM

<u>Danahé Paquin-Ricard</u> [1], *Paul A. Vaillancourt* [2], *Howard W. Barker* [3], *Jason N. S. Cole* [3]
[1] CRCMD, Université du Québec à Montréal
[2] Recherche en Prévisions Numériques, EC
[3] Environment Canada
Contact: danahe@sca.uqam.ca

In general circulation models (GCM), many cloud processes and interactions are often oversimplified within the microphysics, convection, and radiative transfer schemes. Parameters in these schemes are often derived from either observations or physical/statistical relationships; the former are usually limited to specific cases and include observational uncertainty while the latter are often educated guesses since physical processes are not always well understood. Moreover, GCM's are often tuned to balance the global energy budget at the top of the atmosphere and while achieving this goal, they cannot easily reproduce the observed clouds or precipitation. This underlines the fact that the radiative budget can be right for wrong reasons or from compensating biases.

In this project the Monte Carlo Independent Column Approximation (McICA) is tested in the Global Environmental Multi-scale (GEM) model. McICA facilitates a flexible treatment of cloud subgrid-scale variability by the radiative transfer scheme and was formulated to replace fixed assumptions regarding cloud structure via random sampling of possible cloud states produced by a stochastic cloud generator. It produces unbiased radiative fluxes and heating rates with respect to the full, and computationally expensive, independent column approximation. It does, however, introduce random errors that might influence simulations adversely.

In this presentation we compare the impact of the McICA method to the previous fixed assumptions of cloud vertical overlap and homogeneity within the GEM model. The model is run in regional climate mode and results are compared to observations. Model sensitivity is compared for different noise levels and different parameters (from both the radiation scheme and the cloud stochastic generator). Surface and top of atmosphere radiative fluxes are compared with observations and co-variability between cloud variables (e.g. liquid or solid water content) and surface radiative fluxes are examined for different settings.

3B01.4 ID:3389 11:15

Assessment of the potential added value in multi-RCM simulated precipitation

Alejandro Di Luca [1], *Ramon De Elia* [2], *René Laprise* [1]
[1] Université du Québec à Montréal
[2] Ouranos Consortium, Montréal, Canada
Contact: diluca@sca.uqam.ca

High-resolution climate information is necessary in support of climate-impact assessment studies, and present-day General Circulation Models (GCMs) do not run at a resolution sufficient to satisfy these needs. Regional Climate Models (RCMs) were developed with the aim of providing fine-scale climate details over particular regions of the Earth. Although RCMs are widely used in climate research studies, the resolved fine scale variability and their effects in larger scales (i.e., added value) have not been unequivocally identified. Attempts to quantify the benefits of using RCMs over GCMs have proved that the added value is a very complex issue and, so far, efforts in its determination are rare. This presentation will focus on the study of a prerequisite condition needed to produce added value: the generation of small scales features. To investigate the potential added value, we propose a methodological approach that includes the

use of a decomposition technique to separate atmospheric variables in several temporal and spatial scales. The work concentrates on the examination of the precipitation field as simulated by an ensemble of RCMs over North American. Results showing the dependence of the potential added value on various factors such as the choice of the climate statistics (e.g., temporal mean vs extreme events such as the 99th percentile), the region (e.g., complex topography region vs ocean surface) and the season (e.g., convective in summer vs stratiform in winter precipitation) will be presented.

3B01.5 ID:3836 11:30

Arctic Ocean Freshwater evolution from 1979 to 2080 – A Model Study using the Rossby Center Regional Coupled Atmosphere-Ocean Model (RCAO)

Jean-Philippe Paquin [1], *Laxmi Sushama* [1], *Ralf Döscher* [2]
[1] Canadian Regional Climate Modeling and Diagnostic Network (CRCMD) - UQÀM
[2] Sveriges Meteorologiska och Hydrologiska Institut (SMHI), Sweden
Contact: jppaquin@sca.uqam.ca

The evolution and variability of the freshwater content (FWC) and fluxes of the Arctic Ocean is investigated from the end of the 20th to the end of the 21st century using a fully coupled regional climate model RCAO. The variability and trends in the freshwater content are analyzed for the 1980-2000, 2020-2040 and 2060-2080 periods for six simulations of RCAO simulations. Liquid and solid FW fluxes through four sections enclosing the Arctic basins are calculated: Bering Strait, the Canadian Archipelago, Fram Strait and the Barents Sea shelf. This study will also explore the role of the large-scale atmospheric circulation and its variability on the freshwater content, liquid and sea ice exports.

3B01.6 ID:3363 11:45

Simulating Regional Climate Using the Global Environmental Multiscale Model with a Variable Resolution Modeling Approach

Marko Markovic [1], *Hai Lin* [2], *Katja Winger* [1]
[1] UQAM
[2] Meteorological Research Division, Environment Canada
Contact: markovic@sca.uqam.ca

Variable resolution models (also known as stretched grid models, [SGMs]) offer the possibility of using very fine horizontal resolution over specific geographical region of interest, a resolution that cannot be attained using global climate models. Furthermore, a variable grid approach is found to be very efficient in terms of computational time and resources. The fact that SGMs don’t suffer from the lateral boundary condition problem makes variable resolution technique a valuable tool for regional and global climate modeling. In this work we evaluate, a variable resolution option of Global Environmental Multiscale model simulated regional climate over different geographical regions (e.g. North America and

Tropical Pacific-East Indian Ocean) against available observational data and a model control run. Moreover, we investigate possible benefits of variable resolution modeling technique in representing regional climate over North America, with an emphasis on atmospheric teleconnections. Considering sea surface temperature (SST) anomalies to be one of the prevalent forcings in the equatorial Pacific influencing even mid-latitudes this study will investigate the connection between SST and dominant atmospheric patterns using variable resolution climate model.

When the atmosphere and the ocean get along over the Gulf of St. Lawrence (Part 1) / Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent (Partie 1)

Room / Endroit (Ballroom B), Chair / Président (Francois Roy), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B02.1 ID:3723 INVITED/INVITÉ 10:30

Dr. François-Jacques Saucier 1961-2008

Gregory Smith [1], *Simon Senneville* [2], *Denis Lefaivre* [3], *Jean-Francois Dumais* [2], *Francois Roy* [4]

[1] Recherche en Prévision Numérique, Environment Canada, Dorval, Canada
[2] Institut des Sciences de la Mer, Université du Québec à Rimouski, Rimouski, Canada
[3] Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, Canada
[4] Centre Météorologique Canadien, Environment Canada, Dorval, Canada
Contact: Gregory.Smith@ec.gc.ca

During his short life, François-Jacques Saucier's achievements and contributions to the scientific community were phenomenal. He was a pioneer in combining numerical modeling techniques, field data and scientific knowledge to advance our understanding of ocean circulation and variability in Canadian inland seas. He led the development of highly realistic hydrodynamic models with numerous scientific and operational applications; from fundamental circulation studies to ecosystem simulations, climate simulations, and coupled marine and weather forecasts. He authored and co-authored an impressive number of peer-reviewed publications and was a respected scientific advisor in many groups interested in physical oceanography, climate change impacts, and environmental prediction and forecasting. He was fully dedicated to knowledge transfer and training,

collaborating with and supervising several researchers and students from L'Institut des Sciences de la Mer, Fisheries and Oceans Canada, Environment Canada, the OURANOS consortium, and various other groups and universities. François was greatly appreciated by the community and received many honours. The Prize in Applied Oceanography from the Canadian Meteorological and Oceanographic Society was recently renamed in his honour. In this special session we provide an overview of his most significant scientific contributions.

3B02.2 ID:3525 11:00

The Canadian coupled Atmosphere–Ice-Ocean forecast system for the Gulf of St. Lawrence : its past, its present and its impact on the short term environmental forecast in Canada. / Le système canadien de prévisions couplées Atmosphère-Glace- Océan pour le Golfe du Saint-Laurent : son passé, son présent et son impact sur la prévision environnementale à court terme au Canada

Serge Desjardins [1], *Manon Faucher* [2], *Pierre Pellerin* [3], *François Roy* [2], *Hal Ritchie* [4], *Garry Pearson* [1], *Bertrand Denis* [2]
[1] National Lab for Marine and Coastal Meteorology, EC,Dartmouth
[2] Centre Météorologique Canadien,EC,Dorval
[3] Recherche en Prévision Numérique,EC,Dorval
[4] Météorological Research Division,EC,Dartmouth
Contact: serge.desjardins@ec.gc.ca

On the eve of the operational implementation of the coupled atmosphere-ocean-ice on the area of the Gulf of St Lawrence, an historical overview and a look toward the future of this important prototype in short term environmental forecast in Canada is presented. An important aspect of this project was also its validation by meteorologists at the Eastern Canada storm centres and this year by the expert analysts at the Canadian Ice Centre. An overview of the evaluation methodology and tools used will be presented as well.

À la veille de l'implantation opérationnelle du système couplé atmosphère-glace-océan sur le domaine du Golfe du St- Laurent, un survol historique et un regard vers le futur de cet important prototype dans la prévision environnementale à court terme au Canada est présenté. Un des volets importants de ce projet fut aussi sa validation opérationnelle par les météorologistes des centres de prévisions des intempéries de l'est du Canada et cette année par les experts analystes du centre canadien des glaces. Un survol de la méthodologie d'évaluation et des outils utilisés sera aussi présenté.

3B02.3 ID:3504 11:15

Freshwater Pattern in the Gulf of St. Lawrence with Mean River Flow Forcing in Present and Pre-Dammed Conditions

Denis Lefaivre [1], *Simon Senneville* [2]
[1] Canadian Hydrographic Service, Inst. Maurice-Lamontagne, Fisheries and Oceans Canada,

Mont-Joli, Qc
[2] Institut des Sciences de la mer de Rimouski, Université du Québec à Rimouski, Rimouski, Qc
Contact: denis.lefaivre@dfo-mpo.gc.ca

The first part of the study presents the pattern of freshwater distribution in the various regions of the Gulf of St. Lawrence over a typical year. It also quantifies the freshwater timing after spring runoff within these regions. The second part consists of two sensitivity analyses: First, to contrast the pattern of freshwater flow in the Gulf of St. Lawrence in recent years (1968-2008) with the historical (1913-1958) pre-dammed forcing from the St. Lawrence River, and secondly, by regulating the flow of the presently free flowing rivers of the Gulf of St. Lawrence.The St. Lawrence River flow is calculated using the daily water level recordings in Montreal (1913-2008) with those on lakes Saint-Louis and Des Deux-Montagnes (1962-2008). For these lakes, Stage-Discharge relationships are known and their total flow allows to calculate a Stage-Discharge relationship for the St. Lawrence River near Montreal. This flow near Montreal is transferred to Quebec City using the results of a One-Dimensional model and is used as forcing to the Gulf of St. Lawrence model. In assessing the flow over the 1913-1958 period, care has been taken to exclude the influence of ice jam and ice restriction on the mean flow estimate, and to allow the correct evaluation of the spring runoff.

3B02.4 ID:3557 11:30

Providing oceanic initial conditions to the operational coupled atmosphere - ice - ocean forecast system for the Gulf of St. Lawrence

Francois Roy [1], *Gregory Smith* [2], *Bruce Brasnett* [1], *Manon Faucher* [1], *Pierre Pellerin* [2], *Bertrand Denis* [1]
[1] Centre Météorologique Canadien, Service Météorologique du Canada, Dorval, Québec, Canada
[2] Recherche en Prévision Numérique, Service Météorologique du Canada, Dorval, Québec, Canada
Contact: francois.roy@ec.gc.ca

A fully-interactive coupled atmosphere-ice-ocean forecasting system for the Gulf of St. Lawrence (GSL) has been running in experimental mode at the Canadian Meteorological Centre (CMC) for the last winter seasons and is expected to become operational. In order to meet forecast standards at the CMC, the ocean component of the system must be initialized with highly-accurate sea surface temperatures (SST), which in turn drive the meteorological forecast. Here we use an ocean circulation model driven by the Canadian operational Global Environmental Multiscale (GEM) model to nowcast SST. We compare the results with satellite derived analyses and in situ temperature data over a 3-year period. We show that the ocean model converges toward observed SST variability after a few months of spin up (without assimilating or relaxing to SST observations). Based on this nowcast method, a pseudo-analysis system has been developed at the CMC and is now running on a daily basis, providing initial oceanic conditions to the coupled forecast system. Comparisons with in situ data show

that the pseudo-analysis system has accuracy comparable to that of the satellite derived SST analysis produced at the CMC. On average, the pseudo-analysis produces SST biases and error standard deviations on the order of 1 degree Celsius.

3B02.5 ID:3325 11:45

Evaluation of modeled ice fields in the coupled model of the Gulf of St-Lawrence.

Luc Desjardins
Canadian Ice Service
Contact: Luc.Desjardins@ec.gc.ca

The Canadian Ice Service is the branch of MSC which deals with a relatively thin, but very important layer which sits at the boundary between the Ocean and the Atmosphere during many months of the year. The ice (thickness and concentration) over water bodies in Canada plays a significant role in the production of weather. The Canadian Ice Service played an active role in evaluating the forecast of various ice fields of a fully coupled (Ocean-Ice-Atmosphere) model in the Gulf of St-Lawrence during the winter 2009-2010. Such validation will serve to not only improve the weather forecasts but also provide CIS with a state-of-the-art ice model over the Gulf of St-Lawrence. Knowing how the ice will behave in response to the weather will help to ensure that ships operating in the area will navigate using the most efficient routes.

General Atmospheric Sciences (Part 3) / Séance générale sur les sciences atmosphériques (Partie 3)

Room / Endroit (Ballroom C), Chair / Président (Stewart Cober), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B03.1 ID:3424 10:30

Analysis of tropical cyclone activity in three recent versions of the Canadian global numerical weather prediction system

Ayrton Zadra [1], *Bernard Dugas* [1], *Anne-Marie Leduc* [2], *Ron McTaggart-Cowan* [1], *Michel Roch* [1], *Paul Vaillancourt* [1]
[1] RPN/MRD, Environment Canada
[2] CMC, Environment Canada
Contact: ayrton.zadra@ec.gc.ca

In June 2009, the Canadian Meteorological Centre (CMC) made important changes to its global mid-range forecast system. Changes to the model included raising the model lid to 0.1 hPa (64 km); replacing sigma-like (or eta) vertical coordinates with a new hybrid coordinate; adding a non-orographic gravity wave drag scheme; and a new radiative transfer scheme leading to improvements in tropospheric temperature forecasts. Changes to the data assimilation system included assimilation of higher level atmospheric data from ATOVS, AMSU-A channels, GPS radio occultation data; as well as new observation and background error statistics. It has been shown that the new system does not overpredict tropical storms (TS) and tropical cyclones (TC) as much as the previous global system. A new version of the CMC global model is currently under development. The main objective of this project has been to further reduce the TC false alarm ratio in the CMC mid-range forecasts. An adjustment to the trigger function in the deep convection scheme over tropical oceans proved sufficient to reduce the TC false alarm ratio, while keeping other forecast scores practically unchanged. This adjustment is part of a new version of the global prediction system expected to become operational in 2010. In this talk, we present results from the study of various TC properties -- e.g. false alarm ratio, detection rate, central pressure and position error, genesis distribution, potential intensity, genesis potential index – of the three latest versions of the CMC global forecasting system.

3B03.2 ID:3904 10:45

GEM-LAM Convective Forecasts: How Can they be used in an Operational Forecast Environment?

Heather Greene , *Brenda Niska-Aro* , *Brad Power* , *Heather Rombough* , *David Schmidt* , *Olga Stachowiak* , *Chris Wielki* , *Andy Yun*
Prairie and Arctic Storm Prediction Centre, Edmonton, AB
Contact: heathergreene62@gmail.com

The Canadian GEM-LAM is a nested local area model with a horizontal resolution of 2.5 km. The GEM-LAM window for western Canada covers southern BC and southern Alberta. During the summers of 2006 and 2007, a systematic evaluation of the GEM-LAM forecasts of convection over Alberta was carried out in Edmonton. Conclusions were drawn on the utility of GEM-LAM as a tool in operational summer convective forecasting. It was found that while the timing of convective initiation over the foothills was modeled reasonably well; downstream, the subsequent convective development pattern was unreliable. In March 2008, the Milbrandt-Yau condensation scheme was implemented in the model. In order to evaluate any improvements in GEM-LAM performance, eight case studies of convective events over Alberta during the summer of 2009 were completed. This presentation will evaluate the potential benefits of utilizing the GEM-LAM on the forecast desk in convective situations. Various aspects of convection, including convective initiation, convective evolution, convergence zones and dewpoint temperatures, will be examined.

3B03.3 ID:3644 11:00

Convection in January? A dynamical analysis and forecast evaluation of the havoc-causing Ottawa-Montreal snow bursts of 28 January 2010

Shawn Milrad , *Eyad Atallah* , *John Gyakum*
Department of Atmospheric and Oceanic Sciences, McGill University
Contact: shawn.milrad@mail.mcgill.ca

The priority of an operational forecast centre is to issue watches, warnings, and advisories to notify the public about the inherent risks and dangers of a particular event. Occasionally, events occur which do not meet advisory or warning criteria, but still have a substantial impact on human life and property. Short-lived snow bursts, or snow squalls, are a prime example of such a phenomenon. While these events are typically characterized by small snow accumulations, they often cause very low visibilities and rapidly deteriorating road conditions, both of which are a major hazard to motorists. On the afternoon of 28 January 2010, two such snow bursts moved through the Ottawa and lower St. Lawrence River valleys, and created havoc on area roads, resulting in collisions and injuries. These snow bursts were associated with the approach of a strong upper-tropospheric trough and the passage of an arctic front. While we do not usually associate convection or squall lines with the month of January in Canada, preliminary results of a dynamical analysis show that the snow bursts occurred in an environment marked by strong quasi-geostrophic forcing for ascent, and both convective and symmetric instability. In addition to a synoptic- and meso-scale analysis of this event, an overview of National Centers for Environmental Prediction (NCEP) high-resolution Global Forecast System (GFS) operational forecasts will be presented. Finally, this presentation will highlight the need for the development of a standard sub-advisory criteria warning that operational forecasters can issue and quickly disseminate to the general public.

3B03.4 ID:3459 11:15

Objectives and Activities of MSC’s National SAR Winds Project

Laurie Neil , *Vladimir Zabeline* , *Ron Saper* , *Chris Fogarty*
Meteorological Service of Canada
Contact: laurie.neil@ec.gc.ca

A two-year project has been established to evaluate and plan for possible future adoption of synthetic aperture radar (SAR) derived winds for use on an operational basis by the Meteorological Service of Canada. Based on the successful MENTOR project conducted during 2006-2008 in Pacific and Yukon Region, this Canadian Space Agency GRIP-funded project seeks to extend the use of SAR Winds to all marine regions in Canada. In addition to facilitating evaluation and operational use of large quantities of this data by marine forecasters and other multidisciplinary science users, project objectives include a cost-benefit analysis, error analysis, and determination of the optimum system

architecture for a proposed on-going, operational processing and dissemination system. Training of end users is another integral component of the project.

To this end, partnerships are being developed between all MSC Regions, CMC, and the Canadian Ice Service to ensure the project objectives can be met. Science divisions in the regions, particularly the National Labs, are also participating along with all the regional Storm Prediction Centres. Communications systems are also being established to encourage interaction and facilitate learning amongst users. It is interesting to note that a similar program is underway in the United States.

This presentation will briefly review results of previous projects with SAR Winds, describe current objectives and activities, present several examples showing the unique benefits of this data, and describe two possible scenarios for future operationalization of SAR Winds. Promising scientific advances which should lead to continuing improvements in accuracy and utility will also be touched on in this talk.

3B03.5 ID:3965 11:30

Progress on the Use of Meteorological Object Representations For Convective Storm Warnings – an iCAST Update

Norbert Driedger , *Brian Greaves* , *Emma Hung* , *Robert Paterson* , *David Sills*
Environment Canada
Contact: Norbert.Driedger@ec.gc.ca

Thunderstorms have long been conceptualized in abstract terms involving objects that evolve through space and time. The Unified Radar Processor (URP) software used at Environment Canada includes the concept of moving “storm cells”. Cells are represented as ellipses whose size and orientation depend on features extracted from radar volume scans. Cell evolution is extrapolated based on previous ellipse positions and intensities.

Research is underway on the use of conceptualized storm cells for producing warning text. Progress is hampered by the erratic quality of automated cell identification and tracking algorithms. Also, not all tracks should be given equal importance. The saliency of a storm track for communication purposes depends on storm intensity and location with respect to human activity. Reported sightings by spotters can increase the priority of a storm. Lastly, interactions between storm cells and boundaries of various types play an important role in storm evolution. Computer databases still lack much of the needed contextual information involved in storm warning decision making.

A prototype system called iCAST (Interactive Convection Analysis and Storm Tracking) is currently being used to investigate what kind of performance can be expected in human-machine forecasting scenarios. The iCAST system is used on the Research Support Desk (RSD) at the Ontario Storm Prediction Centre

(OSPC). Various aspects of iCAST have been reported elsewhere, but current status of the system will be briefly reviewed.

Region selection by polygon intersection between geographical boundaries and threat area objects will be discussed. Also, progress towards integrating performance measurement into the system will be noted.

3B03.6 ID:3834 11:45

The DND/CF Joint Meteorological Centre

Clarke Bedford
DND
Contact: clarke.bedford@forces.gc.ca

The Canadian Forces are required to be able to sustain a number of deployed operations concurrently as well as the defence of Canada and North America. Weather and oceanographic services are essential enablers to military operations. Serious deficiencies have been identified in the ability of the Canadian Forces Weather and Oceanographic Service (CFWOS) to provide the required domestic and deployed specialized weather support for CF capabilities. The CFWOS has embarked on a modernization and transformation to meet present and anticipated demands.

The cornerstone of the CFWOS revitalization is the creation of a Joint Meteorological Centre, where teams of CF Meteorological Technicians (Met Techs) can properly prepare for deployments, centralized weather information delivery will be provided using modern communications technologies, and Environment Canada meteorologists and IT specialists will provide support and undertake applied science development projects. The CFWOS Transformation Steering Committee has determined that the best location for the Joint Met Centre is the Army Met Centre at CFB Gagetown near Fredericton, NB. This main Land Forces base provides a venue where CF Met Techs can best prepare for their diverse deployed roles.

Forest Hydrology and Water Management / Hydrologie forestière and gestion des eaux

Room / Endroit (Richelieu), Chair / Président (Paul Egginton), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B04.1 ID:4302 INVITED/INVITÉ 10:30

Balancing forest productivity and water quantity and quality in climate change activities

Robert Jackson
Duke University
Contact: jackson@duke.edu

From climate change to forestry and biofuels as mitigation tools, land use affects not just the carbon balance of ecosystems but their water balance and other services as well. Similarly, what happens on one plot of land affects other locations, whether downhill, downstream, or downwind. I will explore the consequences of land use change for water use and chemistry, focusing on transitions between forests, grasslands, and croplands. The goal of this research is to maximize the carbon gain of different land uses and, to the greatest extent possible, improve water quality and minimize water losses.

3B04.2 ID:3945 11:00

Hydrological consequences of harvesting intensity in forested catchments: The Turkey Lakes Watershed Harvesting Experiment

Frederick D. Beall [1], *Samson Girma Mengistu* [2], *Irena F. Creed* [2]
[1] Canadian Forest Service
[2] University of Western Ontario
Contact: fbeall@nrcan.gc.ca

There is considerable information available comparing the hydrologic response to clearcut harvesting to uncut forests while much less is available on partial harvesting techniques. A harvesting experiment was established at the Turkey Lakes Watershed (TLW), north of Sault Ste. Marie, Ontario, in 1997 to compare three harvesting systems, applied to entire catchments, to uncut reference catchments: a diameter limit harvest (all trees larger than 10 cm DBH cut, 89% basal area removal), shelterwood harvest (42% basal area removal) and a selection harvest (29% basal area removal). Streamflow from the catchments was measured continuously for 16 years prior to harvest at V-notch weirs. A combination of empirical analyses and numerical modeling of hydrologic processes revealed that there was little effect of harvest intensity on peaks flows and a moderate effect, proportional to harvest intensity, on median and low flows. We will present and discuss a variety of approaches and metrics for quantifying runoff applied to both the empirical and modeled record.

3B04.3 ID:3390 11:15

Reforestation revisited: streamflow response to headwater reforestation in the Ganaraska River basin, southern Ontario

James Buttle
Trent University

Contact: jbuttle@trentu.ca

The Ganaraska River basin (GRB) experienced severe soil erosion and flooding in the late 19th and early 20th centuries following deforestation along the crest of the Oak Ridges Moraine in the basin’s headwaters. A time-trend analysis (Buttle 1994, Can Geog 38: 240) suggested that headwater reforestation (doubling of forest cover from 1945 to 1960, with subsequent minor increases) led to decreased annual runoff and peak flows and increased low flows. The latter result is not consistent with reforestation studies in other landscapes, which indicate that low flows decline as a result of greater interception and evapotranspiration with an increase in forest cover. Reforestation effects on the GRB’s streamflow were re-examined using an extended hydroclimatic record and a quasi-paired-basin comparison with a nearby basin of similar size and physiography (Duffins Creek basin, DCB) that had not undergone headwater reforestation. Annual precipitation for both basins increased significantly since 1960, with no significant inter-basin differences in annual runoff or runoff/precipitation ratios. Peak daily streamflow from the GRB decreased relative to that from the DCB from the late 1940s to the early 1970s, with no significant inter-basin differences after this time. Low flows increased in both basins, particularly after 1960; however, the increase in low flows in the GRB significantly exceeded that in the DCB, suggesting that reforestation enhanced groundwater recharge beyond that attributable to trends in hydroclimatic drivers of streamflow behaviour. This appears to be the result of greater infiltration opportunities during spring snowmelt in forested areas along the ORM, which more than compensates for increased summer interception and evapotranspiration due to expanded forest cover. Thus, the influence of land cover change on the full suite of hydrologic processes in a particular forest landscape needs to be considered when trying to anticipate the hydrologic consequences of basin reforestation.

3B04.4 ID:4303 INVITED/INVITÉ 11:30

The New "Forest Product"- Water

Ann Mm Bartuska
(Presented by *Ann Bartuska*)
US Forest Service
Contact: abartuska@fs.fed.us

Over one hundred years ago, the National Forests in the United States were established to provide a sustainable supply of timber and abundant water to support a growing nation. Today, we are rediscovering our roots as water becomes an increasingly precious commodity. 58 % of the surface-derived drinking water comes from the public and private forestlands of the U.S. However, development pressures from expanding population centers combined with impacts to the health of our forests from climate change, invasive species and fire are threatening that supply. We are responding in part by focusing forest management of restoration. Equally important is the development of strategies

for adaptation to climate change, both in what is done on the land as well as in the approach to management. Activities in the U.S will be described.

Micrometeorology of Canadian Ecosystems / Micrometéorologie des écosystèmes canadiens

Room / Endroit (Frontenac), Chair / Président (Paul A Bartlett), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B05.1 ID:3681 **10:30**

Seven years of growing season water and energy exchange from an oilsands reclamation cover, Fort McMurray, Alberta

Sean Carey
Carleton University
Contact: sean_carey@carleton.ca

The oilsands mining industry in Canada has made a commitment to restore disturbed areas to an equivalent capability to that which existed prior to mining. In the restoration process, ecosystems are created that bare little similarity to the pre-existing boreal forest at the onset of reclamation. However, certification requires successful reclamation, which can in part be evaluated through long-term ecosystem studies. A reclamation site, informally named South Bison Hill (SBH) has had growing season water and energy balances observed since 2003 utilizing the eddy covariance technique. SBH was capped with a 0.2 m peat-glacial till mixture overlying 0.8 m of reworked glacial till soil. The site was seeded to barley cultivar (Hordeum spp.) in the summer of 2002 and later planted to white spruce (Picea glauca) and aspen (Populus spp.) in the summer/fall of 2004. Since 2003, the major species atop SBH has changed dramatically and by 2009, an aspen stand predominated with heights in excess of 3 m. Climatically, mean growing season (June-August) temperatures did not vary more than 2 degrees C for a given month, yet precipitation varied considerably as 2004 had 91 mm of rain during June-August while 2008 had 271 mm during the same period. With the exception of a dry 2004, SBH increasingly partitioned energy into latent heat, on average, year after year. At the onset of the measurement, SBH approximately ~55% of net radiation (June-August average) partitioned into latent heat. 2004 had ~47%, yet the ratio of LE/Rn increased consistently thereafter to values ~70% in 2009. Larger latent heat fluxes cannot be attributed solely to climate as increased leaf area index, interception and a longer leaf-out period have increased total evaporation. In

most years, evaporation exceeds summer rainfall, utilizing snowmelt recharge to sustain evaporation rates. Comparison with regenerating aspen stands post-harvest shows similar energy and water fluxes.

3B05.2 ID:3505 10:45

Comparing the influence of spatial vs. temporal variations in temperature and moisture on carbon fluxes in an arctic fen

Jonathan Vandewint , *Elyn Humphreys*
Department of Geography & Environmental Studies, Carleton University
Contact: elyn_humphreys@carleton.ca

Northern permafrost regions contain as much as 50% of the global organic soil carbon pool. As climatic change in the arctic continues, changes in the soil moisture and thermal regimes of these northern ecosystems and their influence on carbon dioxide (CO_2) and methane (CH_4) exchange is uncertain. During the 2009 growing season (July to August), measurements of CO_2 and CH_4 fluxes were obtained for an arctic wet sedge fen at Daring Lake NWT using the eddy covariance method. Fluxes from lawns (L) and tussocks (T) in the fen were also measured using a combination of flow-through and static non-steady state chambers. During the study, the water table varied between 5 - 13 cm below the lawn surface and 20 - 33 cm below the tussock surface, resulting in significantly warmer and drier soil conditions in tussocks. Although species composition was significantly different among lawns and tussocks, vegetation characteristics such as leaf area index and percent cover were not. This may help explain the very similar net ecosystem exchange of CO_2 (L: -1.69 ±0.08, T: -1.71 ±0.11 μmol m^{-2} s^{-1} (mean flux ± standard error)), gross ecosystem production (L: -3.60 ±0.10, T: -3.74 ±0.12 μmol m^{-2} s^{-1}), and ecosystem respiration (L: 1.91 ±0.06, T: 2.03 ±0.08 μmol m^{-2} s^{-1}) among lawns and tussocks. Negative values indicate ecosystem uptake. In contrast, CH_4 emissions were significantly greater from the wetter lawns (58.22 ±2.11 nmol m^{-2} s^{-1}) than from the tussocks (34.82 ±1.52 nmol m^{-2} s^{-1}) indicating that the role of vegetation in mediating these fluxes is less important. Average daytime micrometeorological CO_2 and CH_4 fluxes were similar to chamber values but significant diurnal and daily variations highlight the sensitivity of these fluxes to temperature and moisture and in the case of CH_4 fluxes, to turbulence. The potential for using seasonal and spatial variations in C fluxes to inform our understanding of the long-term effects of warming and drying on C fluxes in arctic peatlands will be discussed.

3B05.3 ID:3517 11:00

Relationship between root-zone plant available moisture and Normalized Difference Vegetation Index on the Canadian prairie under drought and pluvial conditions

Julian Brimelow , *John Hanesiak*
University of Manitoba

Contact: umbrimel@cc.umanitoba.ca

Previous work on drought characterization on the Canadian prairies suggest that the number of days during the growing season when the modelled root- zone plant available water (RZPAW) is less than 30% may be useful for identifying those areas where vegetation is experiencing significant moisture stress.

We quantify this relationship by comparing standardized NDVI anomalies with both simulated (from PAMII model) and in-situ measurements of RZPAW. Mean weekly RZPAW values were determined using in-situ soil moisture measurements for three DroughtNet sites in Alberta between June and August 2003 (a year when a significant dry down was observed). These data were compared with weekly standardized NDVI anomalies calculated for the relevant township. The simulated mean monthly RZPAW for July and August were computed between 1999 and 2008 for all prairie Census Agricultural Regions having spatially and temporally homogenous NDVI anomalies.

Analysis of the weekly NDVI and in-situ RZPAW data indicated that there was a high correlation between the standardized NDVI anomalies and in-situ RZPAW, especially when NDVI lagged RZPAW by two weeks. Additionally, the results suggest that a critical RZPAW threshold exists near 35% that is associated with standardized NDVI anomalies of ≤ -1.0 (significantly stressed vegetation). This finding corroborates results from laboratory studies which suggest that many crops begin to show significant water stress for RZPAW ≤ 30%. Comparison between the simulated monthly mean RZAPW and monthly standardized NDVI anomalies for July and August show that NDVI anomalies of ≤ -1.0 were typically associated with RZPAW < 40%, while RZPAW ≤ 25% virtually guaranteed NDVI anomalies ≤ -1.0.

Thus independent soil moisture data suggest that RZPAW below approximately 35% tends to be associated with significantly stressed vegetation (as quantified by NDVI). Implications of these findings for drought monitoring and remote sensing are discussed.

3B05.4 ID:4008 11:15

Estimating a Lagrangian length scale in a forest canopy

Shannon Brown [1], *Jon Warland* [1], *Ralf Staebler* [2], *Paul Bartlett* [3], *Eduardo Santos* [1]

[1] School of Environmental Sciences, University of Guelph
[2] Air Quality Research Division, Environment Canada
[3] Climate Research Division, Environment Canada
Contact: sbrown06@uoguelph.ca

Inverse analytical Lagrangian models provide a promising means of quantifying vertical source and sink strengths within canopies. However, there is uncertainty concerning the fitness of current parameterizations of the Lagrangian length scale (L_L), a key input. Small errors in the length scale can lead to irrational estimations of source distribution profiles. Constraining the Warland-Thurtell (2000) Lagrangian equation using field measurements will help to gain a better understanding of the length scale within a forest canopy. Measurements of net CO_2 flux, soil CO_2 flux, and in-canopy profiles of CO_2 concentrations taken in a mixed forest near Borden, Ontario, Canada, provided the information required to solve for L_L in the Warland-Thurtell (2000) equation. Results of the length scale analysis will be presented.

3B05.5 ID:3750 11:30

Modelling surface radiation in mountain forest ecosystems

Richard Essery[1], *Chad Ellis*[2], *John Pomeroy*[2]
[1] University of Edinburgh
[2] University of Saskatchewan
Contact: richard.essery@ed.ac.uk

Topography and vegetation cover strongly influence the shortwave and longwave radiation reaching the ground and hence influence the micrometeorology of mountain forests. Detailed models of topographic shading and canopy radiative transfer exist, but less attention has been given to the combined modelling of topographic and canopy influences on radiation distributions; such models are required for predicting the impacts of natural disturbances and management practices on forest snow dynamics in complex landscapes. Airborne laser scanning can now provide topographic and vegetation maps of unprecedented detail for input to models. Efficient methods of distributed surface radiation modelling will be discussed and applied to the Marmot Creek Research Basin, Alberta.

3B05.6 ID:3368 11:45

Ground-air gas emission rate inferred from measured concentration rise, within a disturbed atmospheric surface layer

John Wilson[1], *Thomas Flesch*[1], *Patrick Bourdin*[2]
[1] University of Alberta
[2] Bombardier Aerospace
Contact: jaydee.uu@ualberta.ca

This work examines a refined "inverse dispersion" approach for estimating the rate of emission (Q) from a small ground-level source, when the surface layer winds near that source are highly disturbed. The inverse dispersion method under investigation is based on simulation of turbulent trajectories between sources and detectors, using a Lagrangian stochastic (LS) model. At issue is whether it is advantageous to recognize the flow as being disturbed and use a computed approximation to that disturbed flow to "drive" a fully three-dimensional LS model ("3D-LS"), or whether it suffices to ignore flow disturbance and adopt an LS model attuned to the horizontally-homogeneous upwind flow ("MO-LS", as

Monin-Obukhov similarity describes the vertical inhomogeneity). It is concluded that if the concentration detector is positioned close to the flow-disturbing obstacles (in this case, a windbreak), then 3D-LS does provide a markedly better estimate of source strength than does MO-LS.

The upper troposphere and lower stratosphere (UTLS) (Part 3)/ Haute troposphère et basse stratosphère (HTBS) (Partie 3)

Room / Endroit (Joliet), Chair / Président (David Tarasick), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B06.1 ID:3477 INVITED/INVITÉ 10:30

Climate-change induced changes in UV radiation and stratospheric ozone fluxes into the troposphere

Michaela I. Hegglin
University of Toronto
Contact: michaela@atmosp.physics.utoronto.ca

The UTLS is a key region for chemistry-climate coupling, and system-inherent feedback mechanisms can lead to unexpected surprises as will be discussed in this presentation. Chemistry-Climate models (CCMs) consistently predict an increase in the strength of the Brewer-Dobson circulation due to a changing climate, affecting the distribution of stratospheric ozone, especially in the mid-latitude lower stratosphere. The associated changes are likely to affect the amount of ultra-violet radiation reaching the Earth’s surface and the amount of ozone transported from the stratosphere into the troposphere. While the contribution of stratospheric ozone to the total tropospheric ozone budget is only about 10%, it strongly affects ozone concentrations in the upper troposphere, where ozone has a longer lifetime of about one month and its most important impact on the radiative forcing in determining surface temperatures. On the other hand, changes in UV radiation may influence the efficacy of chemical processes in the troposphere, and have adverse effects on human beings and the ecosystem. The changes in UV radiation and stratospheric ozone flux have been quantified over the time period between 1960 and 2100 using the Canadian Middle Atmosphere Model (CMAM) – a world-class chemistry-climate model (CCM). Along with the CMAM results and their implications for the tropospheric ozone budget, I will discuss the role of ozone depletion and recovery in modulating these changes, and the model's capability to represent dynamical and chemical processes in the lower stratosphere and comparison to results of other state-of-the art CCMs in order to gain confidence in its predictions.

3B06.2 ID:3537 11:00

The stratospheric influence on the troposphere in the context of operational medium-range weather forecasts

Saroja Polavarapu , *Josep Aparicio* , *Mark Buehner* , *Cecilien Charette* , *Martin Charron* , *Louis Garand* , *Hai Lin* , *Josee Morneau* , *Michel Roch* , *Paul Vaillancourt*
Environment Canada
Contact: saroja.polavarapu@ec.gc.ca

The stratospheric influence on the troposphere described by Baldwin and Dunkerton (2001) is seen as a downward propagation of the Northern Annular Mode (NAM) signal with time during winter. Previous work has suggested that the NAM in the lower stratosphere 10 days earlier is a good predictor of the surface NAM. In this work, we demonstrate the impact of the stratosphere on the troposphere on shorter time scales, that is, up to 10-days. The stratospheric version of Environment Canada's operational weather forecast model (GEM) shows considerable improvement in 5-day forecasts over the tropospheric model. While the main improvement is in stratospheric forecast quality, significant improvement is also seen in tropospheric forecasts. Here we diagnose the source of the improvement, in order to distinguish between the importance of extra measurements and an improved representation of the stratosphere in the model. If the tropospheric improvement is primarily due to the higher model lid, then further improvements in stratospheric forecasts may arise by raising the lid to the mesopause, even if no extra observations are assimilated.

3B06.3 ID:3442 11:15

Development of an Operational Diagnosis of Stratosphere- Troposphere Exchange at Environment Canada

Michel Bourqui [1], *Mike Moran* [2], *David Tarasick* [2]
[1] McGill University
[2] Environment Canada
Contact: michel.bourqui@mcgill.ca

Prediction of air quality at the surface is complex and requires an accurate representation of chemical sources and transport as well as chemical processes. It is well recognised that the stratosphere is an important source of background ozone for the troposphere. Stratospheric ozone can also enhance surface ozone concentrations during episodes where air is transported from the stratosphere into the boundary layer within timescales of days.

This talk will present the new implementation of an operational diagnosis of stratosphere-troposphere exchange (STE) at Environment Canada (EC). The availability of near- real-time calculations of these diagnostics will provide new insights into STE processes, their frequency of occurrence in different regions of Canada and elsewhere, and their possible impacts on surface air quality. STE predictions could also be used to optimise the planning of activities during STE-related field campaigns and to provide key information for the analysis of ozonesonde data obtained by EC and other agencies. Furthermore, archival of these diagnostics by EC will build a unique data set that will be valuable for fundamental research.

3B06.4 ID:3452 11:30

The Stratosphere Troposphere Exchange Processes (STEP) mission concept

Doug Degenstein [1], *Adam Bourassa* [1], *Ted Shepherd* [2], *Michaela Hegglin* [2], *Donal Murtagh* [3], *Brian Solheim* [4], *Michel Bourqui* [5], *Urban Frisk* [6], *Venkateshwara Pillay* [7]
[1] University of Saskatchewan
[2] University of Toronto
[3] Chalmers Tekniska Hogskolin
[4] York University
[5] McGill
[6] The Swedish Space Corporation
[7] Bristol Aerospace
Contact: doug.degenstein@usask.ca

The Stratosphere Troposphere Exchange Processes (STEP) mission concept is a candidate for the proposed Canadian Space Agency's Atmospheric Processes Of Climate Change (APOCC) mission. STEP is a three instrument package proposed to fly on the Canadian SmallSat bus with a focus on vertically resolved, high spatial resolution measurements of species that are important to the Upper Troposphere and Lower Stratosphere region of the atmosphere. The STEP spacecraft, designed by Bristol Aerospace Limited, will house the Canadian Atmospheric Tomography System (CATS), the Spatial Heterodyne Observations of Water (SHOW) instrument and the Stratosphere Troposphere Exchange And climate Monitor Radiometer (STEAMR). STEP involves a unique combination of industrial, international and academic experience and builds on the heritage of previous Canadian Space Agency funded missions to provide an unprecedented high spatial resolution view of the climate related processes that exist within the UTLS. This paper will outline the mission designed by a team of engineers and scientists from the University of Saskatchewan, the University of Toronto, York University, Chalmers Technical School in Sweden, Bristol Aerospace, COMDEV, ROUTES AstroEngineering and the Swedish Space Corporation.

Low-frequency variability and predictability (Part 3) / Variabilité et prévisibilité à basse fréquence (Partie 3)

Room / Endroit (Chaudière), Chair / Président (Bin Yu), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B07.1 ID:3972 INVITED/INVITÉ 10:30

Characterizing the long timescale variability of the climate system

George Boer
Canadian Centre for Climate Modelling and Analysis
Contact: george.boer@ec.gc.ca

A characterization of long timescale climate variability depends on the length of the record and the statistical approach adopted. At a basic level, variance and covariance statistics of annually averaged quantities provide information if enough data is available to obtain stable statistics. Methods such as fluctuation analysis may be employed, integral/decorrelation timescales may be estimated and long timescale teleconnections may be sought.

We investigate the unforced long timescale variability and covariability of temperature and precipitation, the primary climatological variables, in the multi-model CMIP3 archive and compare the results, in so far as is reasonable from a global perspective, to available observation-based information.

3B07.2 ID:3758 11:00

Trends in Temperatures in the Canadian Arctic from Surface and Satellite Observations

Robert Rabin [1], *Jeffrey Key* [2], *Xuanji Wang* [3]
[1] NOAA/NSSL
[2] NOAA/NESDIS
[3] CIMSS/Univ. Wisconsin-Madison
Contact: Rabin@ssec.wisc.edu

Observations from surface stations across the Canadian Arctic and other locations in Canada are being used to examine long-term trends in mean and extreme temperature (50-100 yrs). Comparison of these trends from available clear sky satellite measurements (AVHRR) during the last 25 years will be presented. In most cases, the trends are consistent. While warming and cooling events are evident at some stations on decadal time scales, these appear to be related in part to interannual change in wintertime large scale pressure patterns such as the Pacific-North American Anomaly (PNA) in the northwest, and the

North Atlantic (NAO) or Arctic Oscillation (AO) in the northeast. However, the records from some stations such as Alert appear to lack any significant long term temperature trends. Time permitting, some recent studies relating trends in temperature and ice cover, and ocean heat transport will be reviewed.

3B07.3 ID:3358 11:15

The magnitude of decadal and multidecadal variability in North American precipitation

Scott St. George [1], *Toby Ault* [2]
[1] Geological Survey of Canada
[2] University of Arizona
Contact: sstgeorg@nrcan.gc.ca

Singular spectrum analysis is used to investigate the relative importance of decadal to multidecadal (D2M) variability in precipitation across North America. In most places, decadal (10 to 20 years) or multidecadal (20 to 50 years) variability makes up less than ten percent of the total variance in either annual or seasonal precipitation, with interannual variability or secular trends having much greater importance. Decadal variability is most prominent (contributing 25 to 30 percent of the total variance) in Minnesota and northern California during winter, and the central Rocky Mountains in autumn. Eastern Québec is the only major region where precipitation exhibits significant variance in the multidecadal band. Precipitation across much of Canada exhibits significant variance at extremely low frequencies (greater than 50 years), but variability at these timescales cannot be separated from secular trends due to the limited length of instrumental climate records. Decadal signals in the discharge of the Sacramento River and, to a lesser degree, the Colorado River are coherent and in phase with similar signals in regional precipitation. Prominent D2M signals do not resemble the low-frequency components of major climate modes such as ENSO or the PDO, which suggests that this behavior is not a product of a simple linear translation of a single climate forcing.

3B07.4 ID:3543 11:30

Changes in equatorial atmospheric zonal circulations in recent decades

Bin Yu , *Francis Zwiers*
Climate Research Division, Environment Canada
Contact: bin.yu@ec.gc.ca

The equatorial zonal circulation is characterized by the atmospheric mass flux, and is calculated using the NCEP-NCAR and ERA-40 reanalysis products. A speed-up of the equatorial circulations over the Atlantic and Indian oceans is found in recent decades in both reanalyses, in conjunction with a slow-down of the Pacific Walker circulation. These changes in the equatorial circulations are consistent with changes in dynamically related heating in the tropics, and with observed changes in precipitation.

3B07.5 ID:3299 **11:45**

An empirical seasonal prediction model of the east asian summer monsoon using enso and nao

Zhiwei Wu
Meteorological Research Division, Atmospheric Science & Technology Directorate, Environment Canada
Contact: zhiweiwu@hawaii.edu

How to predict the year-to-year variation of the East Asian summer monsoon (EASM) is one of the most challenging and important tasks in climate prediction. It has been recognized that the EASM variations are intimately but not exclusively linked to the development and decay of El Niño or La Niña. Here, we present observed evidence and numerical experiment results to show that anomalous North Atlantic Oscillation (NAO) in spring (April–May) can induce a tripole sea surface temperature (SST) pattern in the North Atlantic that persists into ensuing summer and excite downstream development of sub-polar teleconnections across the northern Eurasia, which raises (or lowers) the pressure over the Ural Mountain and the Okhotsk Sea. The latter strengthens (or weakens) the East Asian subtropical front (Meiyu/Baiu), leading to a strong (or weak) EASM. An empirical model is established to predict the EASM strength by combination of ENSO and spring NAO. Hindcast is performed for the 1979–2006 period, which shows a hindcast prediction skill that is comparable to the 14 state-of-the-art multi-model ensemble hindcast. Since all these predictors can be readily monitored in real time, this empirical model provides a real time forecast tool.

The Past, Present, and Future of glaciers in Western North America (Part 1) / Glaciers de l'ouest de l'Amérique du Nord : passé, présent et futur (Partie 1)

Room / Endroit (Capitale), Chair / Président (R.D. (Dan) Moore), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B08.1 ID:3566 **10:30**

Nine decades of change of the Columbia Icefield, Rocky Mountains, Canada.

Christina Tennant [1], *Brian Menounos* [1], *Roger Wheate* [1], *John Clague* [2]
[1] University of Northern British Columbia
[2] Simon Fraser University
Contact: tennant@unbc.ca

The 205 km^2 Columbia Icefield is an important source of freshwater for the Columbia, Saskatchewan, and Athabasca rivers. To assess how the icefield has responded to climate change, we calculated area and volume change for the period 1919 to 2009. We extracted glacier extents and produced digital elevation models (DEMs) from Interprovincial Boundary Commission maps of the Alberta-BC border surveyed from 1918 to 1920, aerial photographs acquired in 1948, 1955, 1966, 1970, 1974, 1979, 1986, and 1993, and SPOT satellite imagery from 2009. We also used Landsat imagery for glacier extents in 2000 and combined these data with a DEM acquired from the Shuttle Radar Topography Mission (SRTM). We applied sequential DEM analysis to calculate volume loss between two epochs. Work is underway to assess area and volume change from the aerial photographs, but preliminary analysis reveals that between 1919 and 2000, the area and volume of the icefield decreased, respectively, by 12% and 9 km^3. Several of the outlet glaciers of the Columbia Icefield, including Columbia, Castleguard, and Saskatchewan glaciers, have thinned up to 200 m. The eastern outlet glaciers – Athabasca, Stutfield, Dome and Kitchener glaciers – have thinned less than southern and western outlet glaciers. These differences are due to differences in debris cover, glacier morphometry, and regional climate.

3B08.2 ID:3957 **10:45**

Fluctuation of small glaciers in the Cariboo Mountains, British Columbia, Canada

Matthew Beedle , *Brian Menounos* , *Roger Wheate*
University of Northern British Columbia
Contact: beedlem@unbc.ca

Small glaciers (<1 km2) are the most numerous of any size class in many mountain regions, but questions remain regarding their response to climate change. Previous studies note that small glaciers have changed little in recent times, while others report that these ice masses have undergone substantial recession over similar time intervals. Small glaciers exist at high elevations, with termini hundreds of meters above those of large glaciers. These locations are rarely free of seasonal snow cover, and frequently mapped from imagery with inadequate resolution, making accurate mapping of their extents problematic. High-resolution, aerial photographs, acquired during late summer with minimal snow cover, provide insight into the response of these small glaciers to climate change since the mid-twentieth century. We utilize such photographs to document glacier change in a portion of the Cariboo Mountains, British Columbia over 11 intervals between 1946 and 2009. The largest glaciers (5 to 20 km2), representing the largest fraction of ice cover in the region, continuously receded, losing up to 1,000 m of length and as much as 20% of their 1946 surface area.

Many small glaciers receded from 1946 until the early-1950s, advanced until the mid-1980s, and receded thereafter. Some glaciers advanced by up to 100 m, their surface area increased by nearly 10%, and only recently receded back to their 1946 extent. Our analysis indicates that it is possible to assess subtle extent changes of small glaciers in response to decadal climate variability but only if suitable imagery exists. Small glaciers in the Cariboo Mountains advanced in response to cool, wet condition during the middle half of the last century. Their topographic setting and climatic sensitivity may cause them to likewise advance in the future if cool, wet conditions prevail.

3B08.3 ID:3953 **11:00**

Fifty years of area and volume change of Tiedemann and Klinaklini glaciers, southern Coast Mountains, British Columbia, Canada

Bruce Ainslie , *Christina Tennant* , *Brian Menounos* , *Peter Jackson*
(Presented by *Brian Menounos*)
University of Northern British Columbia
Contact: peterj@unbc.ca

The southern Coast Mountains contain 28% of the total ice- covered area in British Columbia, and previous research indicates substantial area and volume losses from these mountains during the period 1985-1999. Longer records of glacier fluctuations are required, however, to assess whether these observed changes are unusual in the context of the historical record. To extend this record backwards and forwards in time, we calculated area, elevation, and volume change of Tiedemann and Klinaklini glaciers using glacier extents and digital elevation models (DEMs) from aerial photographs and ASTER satellite imagery over the period 1949 to 2009. We differenced older extents and DEMs from more recent ones to obtain changes in area and elevation which we used to calculate volume loss. Tiedemann and Klinaklini glaciers lost 10% of their area over the observation period. Klinaklini Glacier experienced the highest rates of thinning between 1986 and 2000 similar to other glaciers in the western North America. From 1970 to 2000, Klinaklini Glacier thinned 45 ± 0.1 m and lost 22 km3. Between 2000 and 2006, no detectable change in the glacier’s surface elevation or volume (1.1 ± 1.4 km3) was observed. From 1946 to 2000, Tiedemann Glacier thinned 12 ± 0.2 m and lost 0.9 ± 0.7 km3 of ice. One factor that explains the lower observed thinning and volume loss of Tiedemann Glacier is the heavy debris cover that shrouds its ablation area. Similar to Klinaklini, Tiedemann Glacier experienced no detectable volume change (0.6 ± 0.4 km3) between 2000 and 2006. Sequential DEM analysis produced from medium-scale aerial photography for Tiedemann Glacier for the period 2005-2009 indicates that the glacier has thickened at intermediate elevations. The mean surface elevation change for Tiedemann Glacier over the period 2005-2009 is -0.11 ± 0.11 m. Using a mesoscale atmospheric model (RAMS), we dynamically downscaled temperature and precipitation to the glacier locations to assess the climatic factors that could account for the observed changes in area and volume. After correcting for elevation differences and model biases, the model temperature

outputs were used to drive a degree-day ablation model, which was combined with model precipitation to calculate volume changes. Work is underway to compare volume change determined through both approaches and to assess the regional extent of the de-accelerated volume loss in first decade of the 21st century.

3B08.4 ID:3651 **11:15**

Flux divergence measurements in the glacier boundary-layer.

Dd Scott Munro
University of Toronto Mississauga
Contact: scott.munro@utoronto.ca

A boundary-layer experiment was conducted on the tongue of the Peyto Glacier to investigate turbulent flux divergence in the first 6 m above the ice surface. The experimental design was based on a box model approach, entailing two wind speed, temperature and humidity profile masts, located ~650 m apart, along the anticipated katabatic wind flow line. In addition, two tri-axial eddy correlation systems were installed at the downwind mast location, one fixed at ~2 m above the ice surface, the other a mobile unit that was positioned at 1 m intervals among the 1, 2, 4 and 6 m measurement levels of the profile system. Data were collected on fair weather days during the summer of 2008, when air temperature was well above freezing, allowing strong potential for katabatic wind development. Five-minute averages of the profile data, aggregated to half-hour periods, showed a 4 m level wind speed maximum, with modest down-glacier acceleration and substantial warming of air adjacent to the ice surface. Block averaging of the eddy correlation data resulted in turbulent heat flux measurements that were in broad agreement with bulk transfer estimates of turbulent flux in the first 2 m above the ice surface. Mobile eddy correlation measurements diverged to values lower than fixed height measurement values above 2 m, but not to zero, thus indicating downward heat transfer across the 4 m level. A possible mechanism for this is vertical heat flow seepage across a local wind speed maximum that compensates for horizontal flow divergence along an accelerating flow line.

3B08.5 ID:3825 **11:30**

A benchmark evaluation of glacier melt models

Joseph Shea , *Dan Moore*
University of British Columbia
Contact: jmshea@interchange.ubc.ca

Methods for modelling glacier melt range from simple temperature-indexed (TI) approaches to full energy balance (EB) models. Projections of glacier ablation are required to estimate future glacier dynamics and the hydrological response of glaciated basins to climatic changes, yet it is unclear if more complex melt models are justified for regionally distributed melt modelling. This research ranks the effectiveness of more complex melt models versus the simple TI approach for estimating snow and ice melt totals observed over three years and at four glaciers in the southern Coast Mountains of British Columbia. Results indicate that the full EB model is superior to other modelling approaches, though the improvement in model skill compared with the TI model is within the measurement errors of the observational data. Furthermore, the full EB model incorporated regionally tuned parameterizations for incident shortwave radiation, albedo and atmospheric emissivity. Given the added complexity and data requirements of full energy balance models, and the apparent need for regional or local tuning of parameters describing radiative exchange, the use of simple degree-day models for regional glacier melt modelling is cautiously recommended. Further research is required to improve the within and among region transferability of parameterizations required in both TI and EB models.

Atmosphere, Ocean, and Climate Dynamics (Part 3) / Dynamiques de l'atmosphère, de l'océan et du climat (Partie 3)

Room / Endroit (Pinnacle), Chair / Président (Michael Waite), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B10.1 ID:3669 **10:30**

Effects of the horizontal component of the planetary vorticity on the symmetric instability of a zonal flow

Toshihisa Itano , *Kiyoshi Maruyama*
Department of Earth and Ocean Sciences, National Defense Academy
Contact: itano@nda.ac.jp

Symmetric instability is one of the fundamental instability phenomena seen in the rotating fluids. It occurs within the zonal flow under thermal wind balance against slantwise displacement in the meridional plane. So far, it is investigated under the so-called “traditional approximation” where the vertical component of the planetary vorticity alone is regarded to be important to determine the fluid motion, and neglects the meridional component of the planetary vorticity. However, the role of the horizontal component of the planetary vorticity is recently refocused with increasing knowledge of the geophysical flows. Thus, the present study investigates its effects on the symmetric instability of a zonal flow.

The analyses show that the discriminant of the symmetric instability remains, as in the case with the traditional approximation, the potential vorticity of the zonal

flow. Moreover, even though the directions of the gravity and the absolute vorticity vector are no longer perpendicular, the motion associate with the symmetric instability is decomposed into two independent motions: that is, the buoyancy oscillation affected by the ambient rotation and the inertial oscillation affected by the gravity. The angular frequencies of these two motions equal the maximum and the minimum angular frequencies of the symmetric motion, respectively, and their square product is again proportional to the potential vorticity as in the case with the traditional approximation.

When the traditional approximation is removed on the symmetric instability, the resultant modification is summerized as follows: 1. in the horizontal component of the absolute vorticity, the horizontal component of the planetary vorticity, which is neglected in the traditional approximation, is retained, and 2. the square of the horizontal component of the inertial frequency is supplemented to the square of the buoyancy frequency.

3B10.2 ID:3373 10:45

Linear Baroclinic and Parametric Instabilities of Boundary Currents

Francis Poulin [1], *Xavier Carton* [2], *Marc Pavec* [3]
[1] University of Waterloo
[2] LPO/UBO
[3] Actimar
Contact: fpoulin@uwaterloo.ca

Oceanic boundary currents substantially contribute to the transport of heat, energy and tracers in ocean basins, by advecting and mixing heterogeneous water masses. Both western and eastern boundary currents are prone to barotropic and/or baroclinic instabilities, thus forming meanders and shedding eddies. These eddies are a powerful means to redistribute water masses, since they are large and long-lived. Nevertheless, in the ocean, these boundary currents undergo time variations of their mean properties (width, thickness, mean velocity), due to various phenomena affecting their source (tidal or atmospheric forcing, topographic control) or their upstream course (e.g. vortex or wave absorption). As a result of the time variation of the mean flow, parametric instability can occur. This instability has been much less studied than barotropic and baroclinic instabilities, for boundary currents.

In this work we investigate the linear baroclinic and parametric instabilities of boundary currents with piecewise-constant potential vorticity in a two-layer quasi-geostrophic model. The growth rates of both the normal and singular modes are calculated for the baroclinic instability of steady coastal currents. We show that the growth rates of the normal modes are maximal for a vertically symmetric flow. Furthermore, the vertical asymmetries induced by different layer thicknesses, the presence of a barotropic potential vorticity or bottom topography, all act to damp the growth rates and favor growth at shorter wavelengths. It is shown that this behaviour can be predicted from the conditions for vertical resonance of Rossby waves on the two potential vorticity fronts. Also, the baroclinic instability of the singular modes has larger growth rates at shorter wavelengths and shorter time scales. As well, the presence of a sloping bottom of moderate amplitude favors the growth of these singular modes. Finally, we compute the growth rates of parametric instability of oscillatory coastal flows. We show that subharmonic resonance is the most unstable mode of growth. In addition, a second region of parametric instability is found (for the first time) away from marginality of normal-mode baroclinic instability. It is shown that the functional dependency of the growth rates of parametric instability are similar to that of the singular modes of baroclinic instability. To explain this a mechanism for parametric instability, involving the rapid growth of short-wave singular modes, is proposed.

3B10.3 ID:3717 11:00

Stratospheric Ozone Depletion and Southern Hemisphere Atmosphere-Ocean Coupling

Michael Sigmond [1], *John Fyfe* [2], *John Scinocca* [2], *Cathy Reader* [2]
[1] University of Toronto
[2] Canadian Centre for Climate Modelling and Analysis
Contact: sigmond@atmosp.physics.utoronto.ca

It has been well established that increasing greenhouse gases lead to changes in the strength and position of the tropospheric jet. Model experiments indicate that such changes induce changes in ocean temperatures, sea-ice patterns, and the overturning and zonal circulation of the Southern Ocean. The importance of stratospheric ozone depletion for trends in the Southern Hemisphere tropospheric circulation has only recently been acknowledged. Previous studies have shown that the ozone influence maximizes in summer, and that its contribution to observed tropospheric circulation trends dominates that of increasing greenhouse gases. Due to the anticipated recovery of the stratospheric ozone layer opposite trends are expected for the next ~50 years, opposing the effects of increasing greenhouse gases.

In this study we employ a comprehensive coupled Atmosphere-Ocean General Circulation Model with relatively high vertical resolution in the stratosphere to study the influence of stratospheric ozone depletion/recovery on the Southern Hemisphere surface climate and ocean dynamics. We present results from long (100-year) time-slice experiments with and without stratospheric ozone depletion. The importance of the feedback of the ocean onto the atmosphere is assessed by comparing the coupled response to that in the same model without interactive ocean. Finally, we compare the Southern Ocean response in the time-slice simulations to that in a set of transient simulations in an Atmosphere-Ocean model with interactive stratospheric chemistry.

3B10.4 ID:3805 11:15

Do models capture the tropical origins of North Pacific temperature

variability?

Fabian Lienert , *John Fyfe* , *William Merryfield*
Canadian Centre for Climate Modelling and Analysis
Contact: cccma-student-003@ec.gc.ca

North Pacific sea surface temperature variability associated with the Pacific Decadal Oscillation (PDO) and its tropical origins are issues of intense debate. In regard of seasonal to decadal climate prediction employing coupled climate models, it is important to verify how realistic the North Pacific El Niño-Southern Oscillation (ENSO) response is represented by these models.

In a large ensemble of climate models we find that the simulated response of the PDO to ENSO forcing is delayed on average by about four months because of oceanic mixed layers in the North Pacific that are systematically and profoundly too deep. We also find that the simulated variance associated with the PDO is overestimated by about 50% primarily because of ENSO forcing which is similarly overestimated. Spectral analyses show a greater preponderance of simulated lower over higher frequency variability due to errors originating in the tropics and extratropics. Finally, we find that the magnitude and spatial pattern of land temperature response to PDO and ENSO forcing over North America is realistically represented by the models.

3B10.5 ID:3696 **11:30**

Changes in Aleutian Low strength: frequency analysis from a 1000 year long marine sediment core

Justin Lau [1], *Tara Ivanochko* [1], *Stephen Calvert* [1], *Randolph Enkin* [2], *Judith Baker* [2], *Audrey Dallimore* [3], *Thomas Pedersen* [4]
[1] University of British Columbia
[2] Natural Resources Canada
[3] Royal Roads University
[4] University of Victoria
Contact: justin.lau.hoover@gmail.com

A 2.8 m marine freeze core (Tul05-FC3) collected from Effingham Inlet, a near-permanently anoxic fjord on the west coast of Vancouver Island, British Columbia, has been used to reconstruct environmental change over the last 1000 years. Seasonal sediment deposition at this site reflects terrestrial supply in the winter and marine productivity in the summer, an annual sequence that is preserved as varves. Sedimentary δ13C values reflect the relative contributions of marine and terrestrial organic matter and generally covary with regional instrumental precipitation records. Frequency-time analysis of δ13C determinations has been used to generate a new record of Pacific decadal variability (PDV) spanning AD 1000 to 1970 that agrees well with previously published tree-ring reconstructions. Periods of ~18, 27, 30, 40, and 50 years are evident between 1970 and ~1500 ; however, prior to 1500 only the 50 year period is persistent. These periods are found in records of the Pacific Decadal

Oscillation, positive phases of which result today in relatively dry conditions at our site. This core provides a unique high-resolution record of the last millennium as well as a temporal connection between the instrumental record and a giant piston core collected from the same site, that has yielded a 10000 year long reconstruction of PDV.

3B10.6 ID:3380 **11:45**

Monte Carlo Modelling Of Sea Ice Population Dynamics

Daniel Godlovitch
University of Victoria
Contact: dgodlovi@uvic.ca

A stochastic model of the dynamic evolution of the sea ice thickness distribution is presented. By characterising the dynamics in terms of energy flows, results from statistical mechanics may be used to create a Gibbs Sampler Monte Carlo model. Any ice which has a thickness greater than the thermodynamic equilibrium is created through compressive and shear ridging and thus any model of sea ice evolution must include the effect that ice-ice interactions have upon the population. A point of difficulty in sea ice modelling is in finding a description of the material properties of the ice which affect the ridging process. Rather than using a force-balance approach with a detailed rheology, ridging processes are treated as discrete jumps in the distribution. The model dynamics are driven by external forcing and the rate, or probability of a change occuring depends upon the difference in energy between the present and proposed states. Two variants of the model are presented: a zero dimensional model and a two dimensional model. The zero dimensional model is useful as a tool to explore the relative sensitivity of the ice population to changes in parameters. The two dimensional model adds spatial information including bathymetry. This feature allows the model to be used to study scouring and grounding problems.

Our Roads - Road Weather Service Developments / Nos routes - Le point sur la météorologie routière

Room / Endroit (Bytowne), Chair / Président (Paul Delannoy and Brian Mills), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B11.1 ID:3823 **10:30**

Clarus

Brenda Boyce [1], *Christopher Hill* [1], *Paul Pisano* [2]
[1] Mixon/Hill, Inc.
[2] Federal Highway Administration, Road Weather Management
Contact: Brenda.Boyce@mixonhill.com

The Clarus Initiative, established in 2004, is a multi-year program sponsored by the U.S. DOT's FHWA Road Weather Management Team and the RITA's Joint Program Office to organize and make available more effective environmental and road condition observation capabilities in support of four primary motivations: 1) Provide a North American resource to collect, quality check, and make available surface transportation weather and road condition observations so that DOTs and other transportation agencies can be more productive in maintaining safety and mobility on all roads and surface transportation modes. In addition to increasing productivity, it will maximize their Road Weather Information System (RWIS) and Environmental Sensor Station (ESS) investments. 2) Surface transportation-based weather observations will enhance and extend the existing weather data sources that support general purpose weather forecasting for the protection of life and property. 3) Collection of real-time surface transportation-based weather observations will support real-time operational responses to weather. 4) Surface transportation-based weather observations integrated with existing observation data will permit broader support for the enhancement and creation of models that make better predictions in the atmospheric boundary layer and near the earth's surface to support more accurate forecasts. The Clarus Initiative consists of two development components. 1) The first component was the development of the Clarus System by Mixon Hill – a network for collecting, quality checking, and disseminating observations with the associated metadata and quality checking flags. The deployed Clarus System can be found at www.clarus-system.com. 2) The second component is the development of tools that make effective use of the Clarus System data. Mixon Hill has created two tools that specifically address this component: The Non-winter Maintenance Decision Support System and The Multi-state Control Strategy Tool.

3B11.2 ID:3986 10:45

IntelliDrive(SM) road weather research and development - Using vehicles to diagnose the weather

Sheldon Drobot , *Mike Chapman*
NCAR
Contact: drobot@ucar.edu

One solution for mitigating the adverse impacts of weather on the transportation system is to provide improved road and atmospheric hazard products to road maintenance operators and the traveling public. With funding and support from the U.S. Department of Transportation's (USDOT) Research and Innovative Technology Administration (RITA) IntelliDrive(SM) initiative and direction from the Federal Highway Administration's (FHWA) Road Weather Management Program, the National Center for Atmospheric Research (NCAR) is conducting research to develop a Vehicle Data Translator (VDT) that incorporates vehicle-based measurements of the road and surrounding atmosphere with other, more traditional weather data sources, and creates road and atmospheric hazard products for a variety of users. This presentation will outline existing work on assessing vehicle data accuracy and bias, and highlight how vehicle data can be combined with more traditional weather observations to create road and atmospheric hazard products.

3B11.3 ID:4100 11:00

Mobile Meteorological Observation (M2O) Network

Brian Bell
Global Science & Technology
Contact: brian.bell@gst.com

National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS) is undertaking a major effort to enhance a National Mesonet infrastructure that extends beyond the reach of traditional surface observation of weather data. The National Mesonet will leverage non-federal networks and other sources of environmental data, including those collected by mobile platforms. Working toward that objective, Global Science & Technology, Inc, (GST) has partnered with NWS to build the nation's first mobile meteorological observation (M2O) network. This project entails the acquisition and delivery of mobile environmental data from commercial fleets to NOAA, as well as an evaluation of the data suitability when used in conjunction with traditional surface observations. As part of the project, GST will create standards for raw mobile observations as well as metadata to ensure that data are of high quality and meet the requirements of the meteorological community. The mobile observations will augment and supplement traditional surface observations, whereby decision makers will obtain a more complete picture of the actual environmental situation over a given geographic coverage. Spatial resolution will be denser—showing many more data points—and because the platforms are mobile, the data will be updated frequently. These mobile data will help describe the environmental conditions along and near critical surface infrastructure, as well as along the pathways of the fleet, which include valleys, mountains, and other topography. Government access to the mobile platform environmental data observation network will be provided through a data portal that supports NOAA's objective of monitoring and predicting meteorological and hydrological phenomena at a temporal resolution of less than 15 minutes and spatial resolution of less than five kilometers. Mobile observations offer extraordinary value to weather forecasts and prediction that will be better understood at the conclusion of this project.

3B11.4 ID:3987 11:15

An Update on the Maintenance Decision-Support System (MDSS)

Sheldon Drobot , *Mike Chapman*

NCAR
Contact: drobot@ucar.edu

Over the past ten years, the United States Department of Transportation's (USDOT) Federal Highway Administration (FHWA) has invested in the research and development of a Maintenance Decision Support System (MDSS). The MDSS has been successful at providing the winter road maintenance community with useful strategic (12-48 hours) information regarding winter weather, road weather, and treatment recommendations. During the 2008-2009 winter season, the system was modified to run over a major international airport, which exposed some deficiencies in the way MDSS predicts short-term (0-6 hours) impacts to the road and runway surfaces. A modification to the system is underway to provide more accurate short-term forecasts of precipitation that can be used for tactical winter weather forecasting and also possibly non-wintertime convective forecasts. This presentation will highlight current developments for MDSS

3B11.5 ID:3478 **11:30**

METRo: an update about Environment Canada's Free and Open Source Road Forecast Software

Miguel Tremblay
Environnement Canada
Contact: miguel.tremblay@ec.gc.ca

METRo is a road forecast software created in 1999 by Environment Canada. It has been released under a GPL license in September 2006 and offered to external users.

Since then, METRo's development has been continuous and the number of users continues to grow, both in the private and public sectors. It is currently used in more than 5 countries.

In this talk, we will present who those users are, for what purpose they use METRo, how they communicate between themselves, Environment Canada's role in it's development and support and, finally, the role of the GPL license in METRo's success.

3B11.6 ID:3998 **11:45**

Renewal of the Intensity Duration Frequency curves for Ontario

Frank Seglenieks [1], *Eric Soulis* [1], *Don Burn* [1], *Muhammad Naeem* [2]
[1] University of Waterloo
[2] Ontario Ministry of Transportation
Contact: frseglen@uwaterloo.ca

The Department of Civil and Environmental Engineering of the University of

Waterloo is working in collaboration with the Ministry of Transportation of Ontario (MTO) to establish an appropriate method of predicting extreme precipitation patterns across Ontario. The drainage systems of highway infrastructure must be designed in accordance with expected precipitation patterns in order to find the optimal balance between the effectiveness and the cost. The design process requires local statistics that characterize extreme precipitation. These values are available at points throughout the province. Due to the fact that roadways span the entire province, there must be a method of estimating precipitation patterns between data collection stations. The interpolation method used for this study was the Waterloo Multiple Physiographic Parameter Regression (WATMAPPR) technique. Using this technique, regression equations were derived for an area based on the values of physiographic parameters using the locations of measurement stations. The objective of the work presented in this report is to test the assumption that there are detectable and useful correlations between physiographic characteristics and extreme rainfall statistics.

Ocean Biogeochemistry Responses to Environmental Change / Réactions biogéochimiques de l'océan aux changements environnementaux

Room / Endroit (York), Chair / Président (Helen Joseph), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B12.1 ID:4178 INVITED/INVITÉ 10:30

Ocean acidification: a case study from the Estuary and Gulf of St. Lawrence

Michel Starr [1], *Alfonso Mucci* [2], *Denis Gilbert* [1], *Bjorn Sunby* [3]
[1] Pêches et Océans Canada
[2] McGill University
[3] McGill University/ISMER Université du Québec à Rimouski
Contact: Helen.Joseph@dfo-mpo.gc.ca

Ocean acidification: a case study from the Estuary and Gulf of St. Lawrence

Michel Starr1*, Alfonso Mucci2, Denis Gilbert1, Bjorn Sundby2,3

1 Pêches et Océans Canada, Institut Maurice-Lamontagne 2 Department of Earth and Planetary Sciences, McGill University 3ISMER/Université du Québec à Rimouski

* Michel.Starr @dfo-mpo.gc.ca

Acidification of the upper ocean by invasion of fossil fuel CO2 from the atmosphere is a recent phenomenon of widespread concern. Less ventilated regions of the ocean can in addition be acidified by metabolic CO2 from respiration of organic carbon. The impact of acidification is expected to be felt first at high latitudes and in hypoxic/anoxic waters. We have investigated the pH and the saturation state with respect to calcite and aragonite, carbonate minerals used by a variety of living organisms, at thirteen sections crossing the Lower St. Lawrence Estuary (LSLE) and the Gulf of St. Lawrence (GSL). A three-year time-series of weekly observations of pH, oxygen, and other chemical and physical parameters was collected in the LSLE from 2006 to 2008. These observations were compared to historic data to evaluate how pH and saturation levels have evolved in this region. Persistent zones of corrosive bottom waters were found in the LSLE, the northwest GSL, and at the head of the Esquiman Channel. These zones correspond to the hypoxic waters previously documented by Gilbert et al. (2005). The pH in the LSLE bottom waters has decreased by 0.2 to 0.3 units over the past 75 years. Over the same period, the saturation state of the bottom waters decreased with respect to calcite and aragonite. The bottom waters in the LSLE are presently strongly undersaturated with respect to aragonite. Corrosive water was also found in the shallow southern Gulf of St. Lawrence, but this phenomenon is likely intermittent. The potential impacts on marine fauna and mechanisms that control the spatio-temporal variability of pH and calcite and aragonite saturation will be discussed.

3B12.2 ID:3654 11:00

Signs of eutrophication in the St. Lawrence Estuary?

Suzanne Roy
ISMER Université du Québec à Rimouski
Contact: suzanne_roy@UQAR.QC.CA

This presentation will review information available from the literature which suggests an increase in eutrophication (increased rate of supply of organic matter) in the St. Lawrence Estuary. The recent development of a hypoxic layer in the bottom waters of the Lower St. Lawrence Estuary has been attributed partly to the advection of poorly oxygenated waters and partly to an increased supply of organic matter (Gilbert et al. 2005, Limnol. Oceanogr. 50: 1654-1666). Other indications of the development of eutrophication in this environment include an increased upstream flux of nitrate (Gilbert et al. 2007, Nat. can. 131: 67-75) and signs of a significant increase in pelagic production over the last 40 years from paleoceanographic indicators (Thibodeau et al. 2006, Mar. Geol. 231: 37-50). I will examine how to document this environmental change, what are its possible implications in terms of the food web and the hypoxic layer, and how other coastal environments respond to such changes.

3B12.3 ID:3697 11:15

Expanding hypoxia in the Subarctic Pacific and its impact on BC groundfish

Frank Whitney , *Alan Sinclair*
Fisheries and Oceans Canada
Contact: whitneyf@shaw.ca

Oxygen levels have been declining in the interior waters of the subarctic Pacific throughout our 50+ year oceanic data records, more rapidly so in 25 year records of oxygen along continental margins of North America. The best data sets from the California and British Columbia coasts show oxygen losses of 1.3% per year, resulting in a shoaling of the 60 uM oxygen boundary at a rate of 3 m per year. Over 80% of the BC groundfish biomass is caught in waters with oxygen above 60 uM. Thus, what we deem to be favourable habitat for most groundfish has e.g. decreased from 400 to 325 m depth off the south coast of British Columbia over the past 25 years. A simple projection forward in time, based on a continued oxygen loss rate of 1.3% suggests that the depth range of "favourable habitat" could shrink by 50% between now and 2050. Such a loss of habitat could drive some fish stocks northward towards Alaska where waters are better oxygenated and greatly diminish others.

3B12.4 ID:3884 11:30

Diagenetic Evolution of Sedimentary Mn, Fe, As and Se Concentrations Over 25 Years of Persistent Hypoxia in the Lower St. Lawrence Estuary (Québec, Canada)

Stelly Lefort [1], *Gwenaëlle Chaillou* [2], *Alfonso Mucci* [1], *Bjorn Sundby* [3]
[1] McGill University
[2] UQAR
[3] UQAR/McGill University
Contact: slefort@eps.mcgill.ca

Dissolved oxygen concentrations in the bottom water of the Lower St. Lawrence Estuary (LSLE) have decreased by more than 50% since the 1930s, and are now < 60µmol/L. In response, redox-sensitive elements such as Mn, Fe, As and Se, which are normally concentrated within authigenic phases in the oxic layer of the sediment, might escape to the overlying waters as the sediment oxygen penetration depth decreases concomitantly with the overlying water dissolved oxygen concentrations. This work highlights the chemical evolution of Lower St. Lawrence Estuary sediments following 25 years of persistent hypoxia. In July 2007, two box-cores were sampled in the LSLE. The vertical distributions of Mn, Fe, As and Se in the pore-waters, as well as in both the reactive and total solid-phases, were determined. In comparison to data obtained in the 1980s, pore-waters As and Se concentrations have increased significantly. Reactive Fe and As solid-phase concentrations also increased significantly throughout the entire

sedimentary column, although their total solid-phase concentrations have remained invariant. This is interpreted as a progressive response of the sediment to the decreasing levels of bottom water oxygenation. In addition, short-term sediment core incubations were carried out to assess metal effluxes over a range of overlying water oxygen concentrations encompassing those encountered in-situ and below. Results of these incubations reveal that, whereas the sediment may respond rapidly to changes in overlying water oxygenation, metal fluxes across the sediment-water interface do not vary significantly over short time scales (9 days).

3B12.5 ID:4179 11:45

Ocean Fertilization – a science to policy discussion

Paul Lyon
Fisheries and Oceans Canada
Contact: Paul.Lyon@dfo-mpo.gc.ca

Ocean fertilization continues to be discussed in international forums as a possible geo-engineering technique to counter increased global CO2 emissions. In February 2009, the London Convention/London Protocol initiated the development of a draft “Assessment Framework for Scientific Research Involving Ocean Fertilization”. The framework provides a tool for assessing scientific research proposals on a case-by-case basis to determine, among other things, if a proposed activity is consistent with the aims and objectives of the London Convention or Protocol and meets the requirements, as appropriate. This presentation examines the current scientific knowledge and understanding of ocean fertilization, the uncertainties, and fundamental questions required for informed decision making.

Geophysics in sensitive environmental sites (Part 2) / Géophysique dans les sites écologiquement vulnérables (Partie 2)

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Claire Samson), Date (03/06/2010), Time / Heure (10:30 - 12:00)

3B14.1 ID:3420 10:30

Monitoring of Ethanol Released into an Existing Gasoline Contaminated Zone using High Frequency Ground Penetrating Radar

John Mosquera , *Anthony Endres* , *Juliana Freitas*

University of Waterloo
Contact: mosq.john@gmail.com

High frequency (450 and 900 MHz) ground penetrating radar (GPR) was used to monitor the effects of an ethanol release over an existing gasoline impacted zone at our CFB Borden test site. In September 2009, 185L of denatured ethanol mixture (E95) was released into an unconfined sand aquifer directly over a previous gasoline (E10) release that occurred in August 2008. Prior to the ethanol release, GPR profiling indicated that the gasoline impacted zone was largely confined to the area immediately surrounding its initial injection trench. The GPR profiling performed after the ethanol release observed the initial development of strong reflection events directly below the injection trench which decreased in amplitude and depth over time. Additionally, strong reflections events were observed to propagate laterally away from the trench over a one month period after the ethanol release after which this migration ceased. After the initial expansion, very minor changes in the GPR response were seen until the onset of winter conditions and the development of soil frost. It appears that ethanol inhibited the freezing process of the pore water in the contaminated zone, resulting in a difference in the dielectric properties of the unfrozen and frozen zone. The unfrozen zone area is significantly greater than the spatial extent of the strong reflections event that was monitored after the release, particularly in the down gradient direction of the test cell. This difference in areas suggests that the miscible ethanol phase is separating from the immiscible gasoline phase and moving with the natural groundwater flow. The spatial extent and depth of the unfrozen zone imaged by the GPR profiling has been confirmed by soil probing with a steel rod.

3B14.2 ID:3692 10:45

Laboratory Measurement Of Contaminated And Uncontaminated Sand And Silt Using The Time Domain Induced Polarization Method

Yasaman Khajehnouri [1], *Michel Chouteau* [1], *Jean-Sébastien Dubé* [2]
[1] École Polytechnique de Montréal
[2] Génie de la construction, École de Technologie Supérieure, Montréal, Canada
Contact: yasaman.khajehnouri@polymtl.ca

Induced polarization (IP) is one of the most promising tools for the environmental characterization of urban fills. The measured parameters, electrical resistivity and chargeability, are, in principle, sensitive to changes in soil mineral composition, grain size distribution, water content, pore fluid chemistry, metal content. Contamination of soils by hydrocarbons would then have a site-specific electrical signature. Here we present results obtained from laboratory measurements for two types of soils, sand and silt, to changes in pore fluid salinity, saturation and concentration of hydrocarbon contamination. The contaminant is motor oil. The work is in progress; when it will be completed, it should be possible to assess the IP sensitivity to hydrocarbon concentration (detection level) and in general the effectiveness of the induced polarization method to evaluate the electrical, physical and chemical behavior of the urban fills.

Inox steel electrodes were installed on the side and bottom faces of plastic containers (0.554 x 0.336 m). They were filled with the two soil types. Grain size distribution, porosity and mineral composition using X-ray diffraction analysis were performed before filling the containers. A small vertical perforated tube was installed in a corner of the container to be used as a piezometer for collecting water samples and monitoring water levels during the experiments. Then a sequence of saturation and desaturation with water of increasing salinity was performed. Finally, saturated soil samples were contaminated by the addition of increasing amounts of hydrocarbon. Water chemistry varied from deionized water, tap water to saline water obtained by the addition of NaCl. Water electrical conductivity was measured in the tank filling the container and in the small piezometer installed. Two non-porazible electrodes were installed at the soil surface. Electrical measurements were carried out using IP field equipment (ABEM SAS4000 and Syscal Junior). Each dipole was used as a transmitter dipole while measuring the voltages at all other dipoles. This sequence allowed checking reciprocity and data quality. This dipole scan also allowed imaging the coarse resistivity model within the container. Other measured parameters were the soil bulk dielectric constant and water content (using TDR), temperature and pH. Water samples extracted from the piezometer were analyzed at various times for the main dissolved elements. Finally the collected data were modeled using 3D resistivity inversion (BERT software, T. Gunther). The 3D distribution of electrical properties for each experiment allowed the monitoring of property changes with changes in soil conditions.

Both resistivities and chargeabilities decrease with increase in water salinity for uncontaminated soils. Resistivities and chargeabilities increase with decrease in water saturation. For oil contaminated soils, resistivities increase but chargeabilities decrease with increasing oil.

3B14.3 ID:3732 11:00

Characterization of the petrophysical properties of deep saline aquifers for CO2 storage in the Bécancour area, Québec, Canada

Maxime Claprood [1], *Elena Konstantinovskaya* [1], *Mathieu Duchesne* [2], *Bernard Giroux* [1], *Erwan Gloaguen* [1], *Michel Malo* [1], *Luc Massé* [3], *Jérémie Lavoie* [3]
[1] Centre ETE, Institut National de la Recherche Scientifique, Québec, Canada
[2] Geological Survey of Canada, Québec, Canada
[3] Junex Inc, Québec, Canada
Contact: Maxime.Claprood@ete.inrs.ca

The Intergovernmental Panel on Climate Change has identified deep saline aquifers as a promising geological storage option of carbon dioxide (CO_2). Saline aquifers are identified in the Bécancour area, Québec, Canada. The characterization of the deep saline aquifers is essential step to meet required storage performance criteria to ensure a secure storage of CO_2 in the

underground aquifer, by gaining knowledge about the subsurface geological structure, the trapping mechanism, the formation pressure, and hydrogeological flow. Thirty post-stack seismic lines acquired between 1970 and 2008 and 15 borehole logs are currently available to characterize the saline aquifers in Bécancour. The 2D post-stack seismic data are used to constrain the subsurface velocities at boreholes and to delineate the lateral and vertical extents of the deep saline aquifers in the Bécancour area. Problems encountered include the absence of check shot surveys to complete the time to depth conversion from seismic lines, the limited depth interval sampled on most sonic logs, and low resolution of some seismic lines. Seismic signatures are identified for three saline aquifers targeted: the Trenton limestone, Beekmantown dolomite, and Potsdam sandstone. These seismic signatures are correlated to known gamma-ray signatures to increase the level of confidence of the time to depth conversions. Coefficients of correlation between synthetic traces generated from sonic logs and observed seismic traces are used to fine-tune the time to depth conversion. Tying velocities to reflections corresponding to geological units accurately is the first step necessary to build a geostatistical model of the deep saline aquifers in the Bécancour area. The use of borehole logs and 2D seismic lines allows the characterization of initial parameters concerning the spatial distribution of petrophysical properties of the reservoir and the integrity of the seal.

3B14.4 ID:3808 11:15

Proposed explanation for the unreliability of spontaneous potential as a method for mapping organic contaminants in groundwater

Sarah Forté , *Laurence R. Bentley*
Dept. of Geoscience, University of Calgary
Contact: saforte@ucalgary.ca

A few studies in the past decade have measured negative spontaneous potential (SP) anomalies of several hundred millivolts over contaminated sites. Consequently, SP has been proposed as a method for delineating groundwater organic contaminant plumes. The method is attractive because SP surveys are rapid and non-intrusive.

It is thought that the redox gradients in the degradation halo of groundwater organic contaminants generate measurable electrical gradients. The current theoretical model follows from models for SP over ore bodies and it links SP with redox potential by assuming something equivalent to electronic conduction, perhaps through microbial mats.

We have carried out SP surveys at two hydrocarbon impacted sites in Alberta to better understand the mechanisms and test the applicability of this method locally. Neither site showed the expected negative anomaly. We hypothesize that electronic conduction does not always evolve and at times electron transfer occurs through a chain of reactions, some of which are biologically mediated. If this is the case, the rate of reactions controls the electron flux which we measure

through SP.

To test this hypothesis it is necessary to compare the SP signature of contaminant plumes degrading at different rates. We have chosen to do this using a numerical model with two parts. One part uses the Nernst-Plank equation to calculate the SP due to concentration gradients and the second part is a kinetic reaction model to calculate the concentration distributions. We hope to demonstrate that measurable SP anomalies will only be present when contaminant degradation reactions are rapid, and therefore SP is not always applicable as a method for delineating organic contaminant groundwater plumes.

3B14.5 ID:4086 11:30

Laboratory measurements of electrical properties of mine waste

Michel Chouteau , *Rachid Intissar* , *Michel Aubertin*
École Polytechnique de Montréal
Contact: Erwan_Gloaguen@ete.inrs.ca

Laboratory measurements were carried out to estimate electrical properties of unsaturated mine waste containing high concentration of metal particles for the purpose of constraining the interpretation of electrical survey data. The material studied here comes from a mine waste rock pile belonging to the Tio mine (Québec, Canada). This mine (owned by QIT Inc., a division of Rio Tinto) is considered to be the largest deposit of massive ilmenite in the world. The particle size analysis of samples studied here, already truncated at 10 mm, shows a very widely graded distribution, with a uniformity coefficient of about 30. Electrical resistivity and chargeability were measured as a function of water content and chemistry of the interstitial fluid. To achieve these measurements using 3D electrical tomography, a cylindrical Acrylic column with a diameter of 0.3 m and a height of 1 m was used. A total of 9 levels of stainless steel electrodes, with 8 cm spacing, were installed on the wall of the column. The in-line dipole-dipole, horizontal equatorial dipole-dipole and vertical arrays were used for measurements. The apparent resistivity and chargeability data collected are then inverted to determine the 3D distribution of resistivity and chargeability. The analysis of these 3D models shows that the resistivity is not proportional to the conductivity of interstitial fluid or the water content in contrast with Archie law. This behaviour may be explained by the contribution of electronic conduction through the metal particles. This effect is more important when the resistivity of the interstitial fluid is high or when the moisture material is low. The measured chargeability is high (more than 30 ms) indicating a strong dissemination of mineralization in wastes. This observation is confirmed by XRD mineralogical analysis which shows a concentration of iron oxides (with the most conductive being, ilmenite and hematite) of about 72%. Also the chargeability decreases slightly with the water content, but sharply with the conductivity of the interstitial fluid. For a high conductivity of interstitial fluid, the current preferentially flows through the electrolyte rather than through the particles/electrolyte interface, which reduces the chargeability response.

3B14.6 ID:4101 **11:45**

Experimental Sediment Transport Measurements at Point Pelee National Park

Maria Cioppa , *Eric Gallaway* , *Robert Hatfield* , *Alan Trenhaile*
Department of Earth and Environmental Sciences, University of Windsor
Contact: mcioppa@uwindsor.ca

Sediment erosion and transport are important factors in the creation of coastal landforms, beach configurations and sediment budgets; however, reliable ways to determine rates and directions are still being sought. Complicating factors include grain size, shape, and density, and the direction and velocity of wind, waves and offshore currents. For example, most attempts to estimate longshore sediment transport rates are dependent on models that do not accurately describe movement of the sediment in the swash zone. The magnetic susceptibility (MS) of magnetite is very high relative to other common minerals (e.g. quartz). MS measurements are rapid and accurate, making this technique an attractive proposition for tracking sediment movement. At three locations on the East Beach of Point Pelee National Park (PPNP), the movement of magnetite was tracked using a Bartington MS2D meter over a period of 24 hours, in an attempt to determine the rate of longshore transport in the swash zone. Wind and wave conditions were monitored during the period of the test. In the initial stage of the test, the peak value of MS (indicating maximum concentration of the magnetite) moved with directions and rates consistent with dominant wind direction and velocity, while in the second stage, the overall value of MS decreased, but the peak position did not change. Investigations of the magnetic properties of different size fractions of the sand showed that the magnetic material was concentrated in the finer grain size fractions. These results suggest that while sediment transport is occurring during the first stage, the second stage resulted from sorting and deposition (stabilization) of the finer-grained magnetite. However, the MS-determined transport rates are somewhat lower than those calculated from wind and wave climate data, indicating that further study of this technique is needed.

Atmosphere, Ocean, and Climate Dynamics (Part 4) / Dynamiques de l’atmosphère, de l’océan et du climat (Partie 4)

Room / Endroit (Ballroom A), Chair / Président (Ronald J. McTaggart-Cowan), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C01.1 ID:3813 INVITED/INVITÉ 13:30

The spectra of a general class of stochastic climate models

Richard Kleeman
Courant Institute
Contact: kleeman@cims.nyu.edu

Simple stochastic models of climate have played an important role historically in understanding mechanisms of low frequency variability. Such models can be derived simply from plausible physical mechanisms and are able to account qualitatively for the observed temporal spectra of a variety of phenomena such as mid-latitude SST and ENSO variability.

While undoubtedly not the last word on the complex interaction underlying such phenomena, they provide a compelling first order explanation as well as a "null hypothesis" with which to test more elaborate explanations.

In this talk we derive and analyse carefully the spectral matrix for a general multivariate Ornstein Uhlenbeck process. This class of processes covers many (but not all) influential stochastic climate models. The analysis turns out to have close connections with classical linear resonance and multivariate time series theory.

As a simple application of these ideas we derive a new mechanism to explain decadal ENSO variations.

3C01.2 ID:3784 14:00

Stochastic Averaging of Idealised Climate Models

Adam Monahan [1], *Joel Culina* [2]
[1] School of Earth and Ocean Sciences, University of Victoria
[2] Department of Mathematics & Statistics, Acadia University
Contact: monahana@uvic.ca

Variability in the climate system involves interactions across a broad range of scales in space and time. Models of slow "climate" variability cannot explicitly account for fast "weather" processes, but the dynamical influence of these unresolved scales cannot generally be ignored. Perspectives from statistical physics indicate that if the scale separation between slow and fast scales is sufficiently large, deterministic parameterisations are appropriate, while for smaller scale separations the parameterisations should be explicitly stochastic. The method of "stochastic averaging" provides a framework for the reduction of coupled fast-slow systems into an effective dynamics of the slow variables. This study describes the hierarchy of approximations associated with stochastic averaging, and applies this reduction methodology to a model of coupled atmosphere-ocean boundary layers. As well, stochastic averaging is compared to other stochastic reduction strategies that have been applied to climate models.

3C01.3 ID:3464 14:15

Non-normal Growth in Energy Balance Models

Nancy Soontiens
University of Waterloo
Contact: nancy.soontiens@gmail.com

Asymptotic analysis is a useful tool for determining the long- term behavior of a dynamical system. However, this type of analysis does not reveal much information about the growth and decay of perturbations on short time scales. Often the transient behavior of a system is quite important, particularly in the context of meteorology and fluid dynamics. In my presentation, I will discuss transient growth due to a non-normal operator for energy balance models on Earth and Mars. Non-normal growth is examined while varying the emissivity of the atmosphere. It is found that transient growth can occur for high values of emissivity. Since dust on Mars is generally thought to increase the atmosphere's emissivity, this indicates that dust could produce some interesting dynamics on short time scales. Comparisons are made between the Earth and Mars systems.

3C01.4 ID:3893 14:30

Probabilistic downscaling of surface winds within British Columbia.

Derek Van Der Kamp [1], *Charles Curry* [2], *Adam Monahan* [3], *David Rodenhuis* [1]
[1] Pacific Climate Impacts Consortium
[2] Canadian Centre for Climate Modelling and Analysis
[3] School of Earth and Ocean Sciences, University of Victoria
Contact: derek.vanderkamp@gmail.com

In this project, techniques for statistical downscaling of surface winds in British Columbia were examined, with a view toward assessing possible changes in wind characteristics (mean, direction, and extremes) in future climate scenarios. A probabilistic approach was undertaken in which surface wind probability distributions (PD) for individual WMO-certified stations were approximated with the 2-parameter Weibull distribution. Taking these parameter values as predictands, a variety of large-scale mid-tropospheric variables were then used as predictors in muli-variate linear regressions. In the first approach, used previously in the literature, 20-year seasonal climatologies of predictor variables taken from a 20th century GCM-driven Canadian Regional Climate Model 4 (CRCM4) run were regressed against seasonal climatologies of fitted Weibull parameters. However, the significant correlations provided by these regressions were simply an indication of the models' ability to fit the general seasonal trends common to all stations and predictors; they were not robust to the unique local behavior of predictors. In more recent work, predictors were taken from both NCEP reanalysis data as well as a reanalysis-driven CRCM4 20th century run so as to allow for the inter-annual variability of the surface wind PDS to be fitted by the linear regressions. By developing separate linear regressions for individual

months, a suite of more robust models was developed. Preliminary results suggest that these regression models are able to predict a significant portion of the the historical variability in the surface wind PDs, giving some confidence that this downscaling technique may be used to derive wind characteristics in future climate scenarios.

3C01.5 ID:3679 14:45

Quantifying climate change signal and uncertainty from an "ensemble of opportunities"

Martin Leduc , *René Laprise*
CRCMD Network / ESCER Centre, Université du Québec à Montréal
Contact: leduc@sca.uqam.ca

Atmosphere-Ocean General Circulation Models (AOGCMs) externally forced by enhanced greenhouse gas emission scenarios are commonly used to assess projections of climate change. When an ensemble of several AOGCMs is available for a given scenario, a direct method of analysis consists in using the ensemble mean and ensemble standard deviation of climate change to obtain estimates of the signal and its uncertainty, respectively.

Multi-model ensembles are generally seen as "ensembles of opportunities". This kind of ensemble is not designed to sample the model structural differences in a systematic way but by using only the existing and available models for participating to the ensemble. By using the CMIP3 multi-model dataset, we approach two important issues related to the concept of opportunity: the models independence and the ensemble size.

First, climate models are developed by research centers that share knowledge and model components. Models are hence not completely independent from each other and one can question how their structural similarities can affect the differences between their results, as well as the ensemble statistics (e.g. mean and standard deviation). Also, the small and arbitrary number of models involved for participating to the ensemble can be seen as problematic. Sensitivity of the ensemble statistics is evaluated by using different sizes of sub-samples of models, extracted randomly from the whole multi-model ensemble.

Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 1) / Amélioration de la

compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 1)

Room / Endroit (Ballroom B), Chair / Président (Sean Carey), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C02.1 ID:3395 13:30

Snowcover accumulation and soil freezeback at a site in the western Canadian Arctic

Philip Marsh [1], *Charles Cuell* [1], *Stefano Endrizzi* [1], *Matthew Sturm* [2], *Mark Russell* [1], *Cuyler Onclin* [1], *John Pomeroy* [3]
[1] Environment Canada - National Hydrology Research Centre
[2] Cold Regions Research and Engineering Laboratory
[3] Centre for Hydrology, Univ. of Saskatchewan
Contact: philip.marsh@ec.gc.ca

The accumulation of snow on the ground in tundra areas of northern Canada plays an important role in many aspects of the northern system. For example, the accumulation of snow plays an important role in controlling freezeback of the active layer during the fall and early winter, which is important for determining when heavy equipment utilized for northern development is allowed access to natural terrain. In addition, the distribution of snow at the end of winter plays an important role in controlling snowmelt and runoff. An extensive field program was carried out in the Western Canadian Arctic in order to improve our ability to measure and model the spatially variable snowcover, freezeback of the active layer, and end of winter soil temperature. This study was carried out at Trail Valley Creek, located approximately 50 km NE of Inuvik, NWT, an area characterized by rolling upland tundra, with a mix of tundra, shrub tundra, and forest patches. Extensive snow surveys were carried out at key terrain types; a solid state snow pillow has been installed in a protected forest site to provide a continuous measurement of snow on the ground; snow fall was measured by a weighing precipitation gauge with an alter shield; and arrays of snow depth sensors have been installed at tundra, shrub, drift and forest sites. In addition, extensive surveys of typical snow drifts were carried out at the end of winter. The GEOtop hydrologic model, linked to PBSM, using observed weather data and a LiDAR elevation and vegetation height data set, has been tested for its ability to represent snow on the ground and soil temperatures.

3C02.2 ID:3765 13:45

Processes, parameterisation and prediction for a shrub tundra basin

Richard Essery [1], *Cecile Menard* [1], *John Pomeroy* [2]
[1] University of Edinburgh
[2] University of Saskatchewan
Contact: richard.essery@ed.ac.uk

Accumulation and ablation of snow is influenced by topography and vegetation in complex landscapes. Process models will be presented for the redistribution of snow by wind, burial of vegetation by snow, and transfers of energy between snow, vegetation, bare ground and the atmosphere. Parameterisations of these processes will be combined in a distributed model for the Granger basin of the Wolf Creek Research Basin, Yukon, using lidar mapping of the topography and vegetation cover. Relating vegetation distributions to topographic indices, the distributed model will be used to predict impacts of vegetation changes on the hydrology and micrometeorology of the basin.

3C02.3 ID:3376 14:00

Variability of snowcover and melt of High Arctic extensive, low-gradient wetland: Polar Bear Pass, Nunavut

Jane Assini , *Kathy L. Young*
York University
Contact: jassini@yorku.ca

Precipitation is limited in the High Arctic and most wetlands here rely on seasonal snowmelt to recharge and sustain water levels throughout the growing season. The end-of-winter snowcover and melt pattern of a large, low gradient-wetland (100 km2) located at Polar Bear Pass (PBP), Bathurst Island, Nunavut was estimated in 2008 and 2009 using a combination of field and modelling approaches. Specifically, a terrain based snow survey (snow depth, density) was employed to estimate the snow water equivalent (SWE, mm). A physically based snowmelt model, using input climate data from a series of automatic weather stations located across PBP was then applied to (1) index the snowcover for terrain units found in PBP and to (2) assess the timing, duration and rate of melt for varying wetland terrain units (e.g. ponds, wet meadows, hilltops, valleys, lakes). Results indicate a consistent spatial pattern in 2008 and 2009. Windswept areas such as ponds, hilltop plateaus and lakes accumulated less snow than sheltered stream valleys and hillslopes. Modelled melt showed good agreement with direct measurements of surface melt, and aerial photography and imagery. Local scale climate variability within the wetland modified snowcover receipt and melt. The northern part of the pass accumulated less snow and melted-out at an earlier date than the southern part of the pass. Prevailing winds blowing from the North, re-distributed snow from the north-side to the south. Concurrently, aeolian material from the wind-swept hilltops was deposited on the north-side. This lowered the albedo here, enhanced radiation receipt, and triggered an earlier snowmelt. The differences in snow distribution and melt at PBP have implications for its hydrology; such as ground thaw, evaporation and runoff.

3C02.4 ID:3677 **14:15**

Snow surface albedo response to increasing forest litter after mountain pine beetle

Sarah Boon [1], *Rita Winkler* [2]
[1] University of Lethbridge
[2] BC Ministry of Forests and Range
Contact: sarah.boon@uleth.ca

Given the widespread mountain pine beetle infestation in western North America and associated increases in forest litter production, this study examines the effects of litter on snow surface albedo in south-central British Columbia. Measured changes in canopy transmittance provide an indication of canopy loss (i.e., total litterfall) in a mature, young and clearcut coniferous stand at Mayson Lake, BC. Comparisons of percent litter cover, an index of albedo, snow depth and snow ablation during the 2008 melt season indicate strong relationships between these variables. While initial study results suggest that a relatively small percent litter cover can have a significant effect on albedo and ablation, further research is required to extract the litter signal from that of other factors affecting albedo – particularly snow depth. Experiments are underway to characterize the spectral reflectance properties of specific litter types and determine their effects on snow surface reflectance at varying snow depths and ages. Analysis of additional years of snow ablation, snow surface condition and canopy loss data, and the quantification of relationships between these variables, will enhance our understanding of potential changes in snowmelt patterns in watersheds with extensive forest defoliation.

3C02.5 ID:3334 **14:30**

Snow melt energy balance in a burned versus healthy forest stand, Crowsnest Pass, Alberta, Canada.

Katie Burles , *Sarah Boon*
University of Lethbridge
Contact: katie.burles@uleth.ca

Forest disturbance ultimately opens the forest canopy which plays a major role in the snow melt energy balance, attenuates incoming shortwave radiation, windspeed, temperature, snow accumulation, and increasing incoming longwave radiation. This presentation outlines results from the 2009 winter field program analyzing the impacts of wildfire on snowmelt energetics within two 2500 m2 stands in the area of the 2003 Lost Creek fire in the Crowsnest Pass (AB). Meteorological data collected in both a healthy and burned forest stand were used to calculate the snow melt energy balance. Output values were validated with snow measurements collected during the 2009 spring season. Shortwave radiation was the largest contributor to snow melt in both forest stands with 127% higher inputs in the burned than the healthy site. The removal of forest canopy

caused the longwave flux in the burned site to be 551% lower than the healthy site indicating the flux to be primarily diverging from the snow surface. Higher wind speeds resulted in 65% higher sensible and 175% lower latent heat fluxes in the burned relative to the healthy forest site. Ground heat flux contributions to snow melt were limited, but were observed to be slightly higher in the burned site which corresponded with warmer ground temperatures and lower soil moisture. Although 16 cm more snow water equivalent accumulated at peak snow pack in the burned site, it melted more rapidly and subsequently complete snow pack removal occurred seven days sooner than the healthy site. Study results are the first to quantify energy flux differences in burned versus healthy forest sites, and provide new data that can be used to improve parameterization of large scale watershed models used to assess runoff response to disturbance.

Regional Climate Modelling (Part 2) / Modélisation régionale du climat (Partie 2)

Room / Endroit (Ballroom C), Chair / Président (Bernard Dugas), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C03.1 ID:3365 **13:30**

The role of atmospheric dynamics on the fate of glaciers in the Karakoram, Himalaya.

Tamara Janes , *Andrew Bush*
University of Alberta
Contact: tamarajjanes@gmail.com

High-resolution regional climate simulations of the Karakoram, Himalaya have been performed for investigation into the atmospheric dynamics in this region, and their role in the Karakoram's snowfall accumulation and glacier dynamics. It has been seen through a combination of field measurements and satellite observations that glaciers in this region appear to be reacting differently to contemporary climate change. This region has exhibited a relatively large number of either static or advancing glaciers whilst other glaciers in the central and eastern Himalaya, as well as around the world, are nearly all retreating. The amount of precipitation received in the Karakoram region depends on the interplay between two climate systems: the westerly winds blowing over the Mediterranean and Caspian Seas, and the summer Asian monsoon winds that blow over the Indian Ocean. This study extends the modeling time frame by performing time slice calculations for both the future (out to the year 2100) and the past (back to 9000 years before present). Using data from the GFDL global

atmosphere-ocean model (Gordon et.al, 1982) infused with a 2xCO2 atmospheric composition regime as boundary conditions for the NCAR/PSU Mesoscale Model 5 (denoted as MM5), it is found that while some parts of the region experience a decrease in accumulated precipitation of all forms at the year 2100, there are distinct regions in which the opposite is true, specifically around the vicinity of K2. These increases in precipitation can offset the increase in melt due to warmer global temperatures predicted in 2100.

3C03.2 ID:3722 13:45

Sensitivity of Glacial Change Detection to Datum Transformations

Tristan Goulden [1], *Chris Hopkinson* [2], *Mike Demuth* [3]
[1] Dalhousie University
[2] Applied Geomatics Research Group
[3] Geological Survey of Canada
Contact: tgoulden@dal.ca

Physical changes in our environment characterize shifts in global patterns and are indications of climate change. Alpine glaciers are highly sensitive to variations long term climatic variations. To chronicle the activity of alpine glaciers an analysis of legacy data and comparison with modern observations is necessary. The historical record of alpine glaciers often consists of paper topographic maps produced in out-dated geographic datums. For appropriate change detection it is essential all data be spatially coincident requiring historical observations be transformed to a modern datum. Failure to execute this will lead to incorrect conclusions about the glacial system and subsequently false implications of climate change. In Canada, horizontal reference of historical map products was the North American Datum of 1927 (NAD27) and current map products is the North American Datum of 1983 Canadian Spatial Reference System (NAD83 CSRS). An analysis of the sensitivity of three glacial sites in Western Canada was completed to determine the effects of ignoring datum transformations in the change detection process. This was performed by purposefully comparing historical glacial surface observations in NAD27 with current observations in NAD83 CSRS. Consideration was also given to the sensitivity of derived change to vertical reference systems. This focussed on the ability of current satellite positioning technology to produce elevations directly to the surface of the reference ellipsoid while historical data is traditionally referenced to mean sea level. From the sensitivity analysis key distinguishing characteristics of these errors were identified to quickly ascertain whether observed changes are the result of a physical trend in the environment or negligence in reconciling spatial reference.

3C03.3 ID:3648 14:00

Impact of Climate Model Resolution and Configuration on Simulated African Easterly Waves and Atlantic Tropical Cyclone Activity

Louis-Philippe Caron [1], *Colin Jones* [2], *Katja Winger* [1]

[1] Université du Québec à Montréal
[2] Rossby Centre, SMHI
Contact: lpcaron@sca.uqam.ca

In this presentation, we discuss the ability of GEM, run in a number of different configurations, to simulate the observed variability in Atlantic Tropical Cyclones over the recent past. Specifically, we have run GEM in a number of configurations, using observed Sea Surface Temperatures (SSTs) for the period 1979-2006. The different configurations include (i) a 2º Global, regular resolution version of GEM, ii) a 1º Global, regular resolution version of GEM, (iii) a Limited-Area (LAM) domain of GEM covering only the tropical Atlantic and iv) a LAM domain covering both the tropical Atlantic and the entire North Africa. These two LAM domains are both run at 0.3º resolution and are forced by results from integration (i) and (ii), namely output from the Global regular resolution integrations. (v) (vi) 2 LAM versions of GEM, employing the exact same resolution and domain coverage as the LAMs in (iii) and (iv), but employing ECMWF Reanalysis data as lateral boundary forcing, rather than output from the GEM-Global runs.

By intercomparing the ability of each of these configurations to simulate the observed number, geographical distribution, seasonal and interannual variability of Atlantic tropical cyclones, we highlight the importance of factors such as: (i) Model resolution local to the Atlantic Basin, (ii) Importance of the inclusion of a high-resolution representation of the upstream African Easterly Wave (AEW) track in LAM configurations, versus AEWs being represented on the LAM boundaries as derived from the low resolution GCM run (iii) the importance of employing ERA40 versus GEM lateral boundary conditions.

3C03.4 ID:3637 14:15

Designing perturbed-parameter RCM simulations given finite computational resources

Leo Separovic [1], *Ramon De Elia* [2], *René Laprise* [1]
[1] Université du Québec à Montréal, Centre ESCER, CRCMD
[2] Consortium Ouranos, Université du Québec à Montréal, Centre ESCER, CRCMD
Contact: separovi@sca.uqam.ca

A thorough sampling of regional climate modelling uncertainty originating in RCM’s unconstrained physics parameters requires RCM simulations performed for a large number of different parameters’ settings. This imposes the need for computational resources still out of reach for the majority of research centres. We examine the approach to quantifying RCM parameter uncertainty using short, seasonal RCM integrations, to help reduce the cost of parameter perturbation sampling.

In the preliminary, control experiment, a perturbed-physics ensemble (PPE) of RCM integrations is generated over a large domain, for perturbations of the two parameters that control deep convection and large-scale condensation processes. Based on the single (one-at-a-time) and simultaneous multiple-parameter perturbations we estimate the additive and feedback components of the change in the RCM's seasonal climate (signal) induced by simultaneous parameters' variation. Parameter perturbations also excite large internal variability (noise) and multiple integrations with perturbed initial conditions are performed for each parameter setting in order to robustly estimate the signal induced by the variation of parameters.

As an attempt to better constrain the model solution and reduce the noise, the PPE is re-generated: (1) with the application of the "spectral nudging" and (2) over a domain of considerably reduced size. Beside the reduction of the number of runs needed to robustly estimate the signal in these experiments, another important feature is the alteration of the properties of the signal with respect to the control experiment.

3C03.5 ID:3988 14:30

The Sensitivity of Regional Climate Simulations to Domain Size and Large-Scale Driving Technique

Dragana Kornic , *René Laprise* , *Martin Leduc*
Université du Québec à Montréal, Montréal, Canada; Centre ESCER, Montréal, Canada
Contact: kornic@sca.uqam.ca

The sensitivity of Canadian Regional Climate Model to domain size and large-scale spectral nudging is studied. It is known that the area of integration of the regional climate model must be large enough to allow the full development of the small-scale features. If the integration is performed on a very large domain, it shows important departures from the driving data unless large scale driving is applied. The nudging technique consists in forcing large-scales not only at the lateral boundaries but also within the domain of integration. Three experiments were performed; two experiments with different nudging intensity and one without spectral nudging, over five different domain sizes.With the increase of large-scale nudging intensity we observe the increase of spatial correlation between the simulation and their reference with the increase of domain size. Taylor diagrams for each study show the increase in temporal correlation of small-scale features of few tenths of percents for the largest domains with the highest values of nudging coefficient.

3C03.6 ID:3372 14:45

Diurnal Variations of Land Surface Wind Speed Probability Distribution over North America

Yanping He [1], *Adam Monahan* [1], *Norman Mcfarlane* [2], *Katja Winger* [3]
[1] University of Victoria
[2] Environment of Canada

[3] Univ. of Quebec in Montreal (QUAM)
Contact: yhe@uvic.ca

Knowledge of diurnal variations of the land surface wind speed probability distribution is necessary for understanding and representing diurnal variations of wind power, surface fluxes, surface precipitation, and dust emission. The diurnal cycle of surface wind speed (SWS) probability distribution over North America is analyzed in three-hourly observations of surface winds from 519 weather stations, one global climate model (GEM- GLOBAL) and two regional climate models (GEM-LAM and CRCM4) during the study period of 1979 to 1999. It is found that the observed diurnal amplitudes of the leading three moments of SWS varies among the four seasons with a minimum in the winter (DJF) and a maximum in the summer (JJA); However, the diurnal phase is the same in all four seasons with mean and standard deviation (std) of SWS peaked around noon and the skewness peaked around midnight in more than 70% of weather stations over North America. Exceptions to this patterns are found over mountain regions, where the mean and std of SWS peaks in the late afternoon and its skewness peaks in the early morning. In the summer, the most frequent diurnal amplitudes are found to be approximately 0.6 m/s for mean SWS, 0.3 m/s for the standard deviation, and 0.45 for the skewness. Among the three Canadian climate models, the global climate model GEM-Global with a 1.5-degree resolution simulates no diurnal variation of 10 m SWS; CRCM4 driven by NCEP reanalysis and finer representation of land surface properties simulates smaller than observed diurnal amplitudes and incorrect diurnal phases for leading three moments of SWS; the GEM-LAM driven by ERA-40 reanalysis and the same horizontal resolution (45 km) as that of CRCM4 simulates reasonable diurnal variations of the SWS probability distribution with its peaked diurnal phase ahead of observations by a few hours particularly over the great plains. Physical mechanisms for features of diurnal SWS in observations and three climate models will be investigated and presented during the presentation.

Cloud-Aerosol Interactions (Part 1) / Interactions nuages-aérosols (Partie 1)

Room / Endroit (Richelieu), Chair / Président (Philip Austin), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C04.1 ID:3347 **13:30**

Global modelling of aerosol microphysics and cloud droplets

Knut Von Salzen [1], *Xiaoyan Ma* [1], *Yiran Peng* [1], *Jiangnan Li* [1], *Jason Cole* [1], *Richard Leaitch* [2], *Jonathan Abbatt* [3], *Nicole Shantz* [4]

[1] CCCma, Environment Canada
[2] CCMR, Environment Canada
[3] Dept. Chemistry, University of Toronto
[4] Cloud physics, Environment Canada
Contact: knut.vonsalzen@ec.gc.ca

A numerically efficient method for simulations of aerosol size distributions has been included in an experimental version of the fourth generation of the Canadian Atmospheric Global Climate Model (CanAM4). The model includes parameterizations for microphysical processes for different types of inorganic and organic aerosol from anthropogenic and natural sources. Interactions of aerosols with clouds are included in the model through a prognostic representation of the aerosol activation process. First results of the new model system will be presented and compared to results from the bulk aerosol scheme that is currently used in the standard version of CanAM4. Implications for the effects of aerosols on climate will be discussed.

3C04.2 ID:3436 13:45

Evaluation of aerosol indirect effect in CanAM4 using CERES and MODIS satellite data

Xiaoyan Ma , *Knut Von Salzen* , *Jason Cole*
Canadian Centre for Climate Modeling and Analysis, University of Victoria
Contact: xiaoyan.ma@ec.gc.ca

The first aerosol indirect effect in CanAM4 is evaluated using data retrieved from CERES and MODIS satellites between 2001 and 2005. Different parameterizations for cloud droplets were evaluated in CanAM4 using, in part, a cloud simulator which diagnoses cloud macro- and mirco-physical information at different cloud top pressures and are consistent with the satellite retrievals. Substantial differences were found between simulated and satellite retrieved cloud droplet sizes for some of the empirically-based cloud droplet number concentration parameterizations. Therefore satellite-based retrievals of cloud effective radius were used to constrain the cloud droplet number parameterizations in the CanAM4. We then examined dependencies between simulated, and retrieved, low cloud effective radius and the concentration of different aerosol types. This analysis suggests that both sulphate and organic carbon aerosols contribute to the aerosol first indirect effect on a global scale.

3C04.3 ID:3643 14:00

Assessing simulated cloud radiative properties using properties of clouds whose tops are exposed to space

Jason Cole [1], *Howard Barker* [2], *Norman Loeb* [3], *Knut Von Salzen* [1]
[1] Canadian Centre for Climate Modelling and Analysis
[2] Environment Canada
[3] NASA Langley Research Center

Contact: Jason.Cole@ec.gc.ca

Top of atmosphere (TOA) radiative fluxes and cloud optical properties are diagnosed according to clouds whose tops are exposed to space within user-defined pressure ranges. This methodology is illustrated through analysis of the TOA radiation budget inferred from observations made by Clouds and the Earth's Radiant Energy System (CERES) satellite-based radiometers and simulated by a developmental version of the Canadian Centre for Climate Modelling and Analysis atmospheric global climate model (CanAM4). While the model's monthly-mean all-sky TOA shortwave and longwave fluxes agree well with those from CERES, the methodology developed here reveals that these agreements rest often on underlying compensating biases in simulated cloud properties. Most notably, low and middle cloud albedos simulated by CanAM4 are larger than those inferred by CERES. This is attributed to CanAM4 simulating cloud optical depths that are too large.

3C04.4 ID:4063 14:15

Cloud response to temperature/subsidence perturbations in the CANAM4 single column model.

Philip Austin , *Xue Wei*
University of British Columbia
Contact: paustin@eos.ubc.ca

Three different cloud regimes: trade cumulus, stratocumlus and cumulus are modeled using the Canadian Centre for Climate Modeling and Analysis single column version of the CANAM4 global model. The runs are part of the Cloud Feedback Model Intercomparison project's effort to compare both single column models and large eddy simulations under two sets of conditions: a control run with sea surface temperature and large scale subsidence consistent with current climate, and a perturbation run in which the sea surface temperature is increased by 2 degrees and the subsidence is adjusted so that it is balance with radiative cooling given fixed relative humidity. The trade cumlus and stratocumulus simulations shows a decrease in cloud fraction and liquid water path under perturbed conditions that produce net cloud radiative forcings at the top of the atmosphere of 9 and 16 W/m^2 respectively, indicating positive cloud feedback.

3C04.5 ID:3793 14:30

Sensitivity tests of aerosol effects in CCCma-SCM with Triple-Moment Microphysics

Xingbao Wang [1], *Peter Yau* [1], *Knut V. Salzen* [2]
[1] McGill University
[2] CCCma
Contact: xingbao@zephyr.meteo.McGill.CA

The Milbrandt and Yau (MY) cloud microphysics scheme is coupled with von

Salzen's chemistry-aerosol model using piece-wise lognormal approximation to represent the aerosol size distribution. The coupled system is tested in the CCCma single column model (SCM15h).

The aerosol model produces the number concentration of cloud condensation nuclei (CCN) under specific supersaturation conditions. The CCN is then used for cloud droplets nucleation in the microphysics. The MY scheme predicts two moments of the size distribution (mass mixing ratio and total number concentration) for cloud droplets and three moments (mass mixing ratio, total number concentration, and radar reflectivity) for rain, ice, snow, graupel, and hail particles. The coupled scheme is evaluated by comparing a month long simulation against measurements from the March 2000 ARM (Atmospheric Radiation Measurement) cloud observations. The results indicated that, relative to the existing CCCma-SCM microphysics, the new scheme predicts better the evolution and distribution of the liquid water content, ice water content, and the effective radii for cloud droplets and ice particles. The predicted precipitation at the surface also shows better agreement with observations.

Sensitivity tests show that as CCN increases, the cloud liquid water content and liquid water path substantially increase, so are the monthly mean outgoing longwave radiation (OLR) and downward longwave radiation (DLR) at the surface. On the other hand, the effective radius of cloud droplet, the precipitation, and the flux of shortwave radiation (FSS) at the surface are decreased. The total effects on the radiation resulted in an increase in the monthly mean temperature at the surface.

3C04.6 ID:3982 **14:45**

Mineral Dust Aerosol Simulation with Piecewise Log-normal Approximation (PLA) in GCM

Yiran Peng , *Knut Von Salzen* , *Jiangnan Li* , *Xiaoyan Ma*
Canadian Centre for Climate Modelling and Analysis.
Contact: yiran.peng@ec.gc.ca

Mineral dust aerosol is one of the important contributors to global aerosol loading and optical depth, therefore has potentially strong effects on climate. A new size-resolved dust scheme based on the numerical method of piecewise log-normal approximation was developed and implemented into the fourth generation of the Canadian Atmospheric Global Climate Model (CanAM4). Results are compared with multiple surface measurements near and away from large dust source regions, validating the generation, transportation and deposition of dust in the model. Radiative properties of dust aerosol are derived from approximated parameters in two size modes with Mie theory calculation. The simulated dust optical depth is compared with several satellite observations.

Weather and Climate Monitoring in Canada - Current operations and future directions (Part 1)/ Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 1)

Room / Endroit (Frontenac), Chair / Président (David Wartman), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C05.1 ID:3576 **13:30**

Reference Climate Stations (RCS) Network Purpose, Past, Present, and Future

John Macphee
MSC - Monitoring
Contact: john.macphee@ec.gc.ca

Canada's Reference Climate Stations (RCS) Network is a critical network for documenting and understanding climate change and variability. MSC has designed and implemented a network which will allow researchers using this data 50 or more years hence to confidently state how the Canadian climate has changed. This presentation will review the network history, its present state, and its future. We will review and explain the mix of stations which comprise the RCS network. The presentation will finish with a review of the datalogger based automated station which is at the core of the network, its instrument configuration, maintenance protocols, and the standard to which it is maintained.

3C05.2 ID:3584 **13:45**

Monitoring climate in the Nunavik

Martin Elie
Environment Canada
Contact: martin.elie@ec.gc.ca

The Arctic temperature trends are changing. Meteorological systems are increasing in strength and in frequency. Sea levels are also increasing. The MTQ (Ministère du Transport du Québec) initiated a project in the Nunavik to evaluated maritime installations construct in the past to see if they would withstand these changes. Environnement Canada, monitoring and technologies section, is part of the project by participating in the installation of meteorological

stations in six different communities. Three stations were installed in autumn 2009 and the remaining stations are schedule for spring 2010. Environnement Canada also installed a RCS (Reference Climate Station) station in the Parc national des Pingualuit for monitoring climate changes in summer 2009. Technicians will present the station planning, installation, maintenance problematic and technologies used.

3C05.3 ID:3816 14:00

The Eureka Weather Station Past, Present and Future?

Ken Wowryk
Meteorological Service of Canada
Contact: KEN.WOWRYK@EC.GC.CA

The Eureka Weather Station was established in April of 1947. In the 63 years since inception the station has evolved into a major hub and resource for research in the high arctic while still maintaining its role as an Environment Canada weather station. This presentation will touch on the past, present and potential future activities at Eureka and in the area.

3C05.4 ID:3766 14:15

The role of the Stony Plain Weather Station within the Canadian Upper Air Network

Andrea Faechner
Environment Canada
Contact: darren.tessmer@ec.gc.ca

The Aerological and Surface Operational Programs (ASOP) Section within Prairie and Northern plays a unique role within the Meteorological Service of Canada's atmospheric monitoring framework. Stony Plain, Alberta is the operational hub of this section, serving as both the Aerological training facility for the majority of upper air stations in Canada as well as the monitoring centre for all 31 stations within the Canadian Aerological Network. In addition, Stony Plain remains a fully operational station, completing two upper air soundings per day and maintaining a modified surface weather program. This presentation will highlight the importance of the Stony Plain weather station and the programs that it supports.

3C05.5 ID:3625 14:30

The role of an atmospheric monitoring technician with Prairie and Northern Region

Wayne Emond
Environment Canada
Contact: wayne.emond@ec.gc.ca

Prairie and Northern region has about 50 meteorological technicians that perform duties ranging from conducting surface weather and aerological observations to marine buoy deployment to installation and maintenance of staffed and automated weather stations throughout the region. This presentation will look at the range duties of our technical services officer based in Iqaluit, Nunavut.

3C05.6 ID:4117 14:45

Annual NE Pacific Weather Buoy Servicing Trip aboard the CCGS Sir Wilfred Laurier - Discussion from the field technicians perspective.

Pat Wong , *Bijan Rasti* , *Denis Erdely* , *Bruce Lohnes* , *Vaughn Williams*
Environment Canada
Contact: pat.wong@ec.gc.ca

Environment Canada's West Coast moored buoy network consists 17 buoys, made up of thirteen coastal 3 metre discus buoys, one experimental 3 meter discus buoy and three offshore 6 metre NOMAD buoys. The electronic payload systems used are the Watchman 100©, designed and built by Axys Environmental Systems in Sidney, British Columbia. The deployment, recovery and maintenance of the Pacific & Yukon Region's ODAS buoy network is a joint effort involving Environment Canada, Canadian Coast Guard, Fisheries and Oceans Canada and Axys Environmental Systems. Each of these organizations supplies their own required expertise to the buoy program. The continued cooperation of the government departments and private industry has resulted in a very cost effective and reliable moored buoy program.

Low-frequency variability and predictability (Part 4) / Variabilité et prévisibilité à basse fréquence (Partie 4)

Room / Endroit (Joliet), Chair / Président (Hai Lin), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C06.1 ID:3469 INVITED/INVITÉ 13:30

Toward A Seamless Process for the Prediction of Weather and Climate: the advancement of sub-seasonal to seasonal prediction

Gilbert Brunet
Meteorological Research Division, Environment Canada
Contact: gilbert.brunet@ec.gc.ca

The World Weather Research Programme (WWRP) and World Climate Research Programme (WCRP) have identified collaborations and scientific priorities to accelerate advances in analysis and prediction at sub-seasonal to seasonal time scales in order to: i) advance knowledge of mesoscale to planetary-scale interactions and their prediction; ii) develop high-resolution global-regional climate simulations with advanced physical processes representation to improve the predictive skill of the sub-seasonal and seasonal variability of high-impact events, such as seasonal drought and floods, blocking, tropical and extratropical cyclones; iii) contribute to the improvement of data-assimilation methods for monitoring and prediction of the coupled ocean-atmosphere-land and Earth system; iv) develop and transfer related diagnostic and prognostic information tailored to user needs for accurate weather and climate forecasts and their socio-economic decision making.

3C06.2 ID:3743 14:00

Progress in global GEM-NEMO Coupling

Jean-Marc Bélanger [1], *Gregory Smith* [1], *François Roy* [2], *Harold Ritchie* [3]
(Presented by *C. Harold Ritchie*)
[1] Meteorological Research Division, EC, Dorval QC
[2] Canadian Meteorological Centre, EC, Dorval QC
[3] Meteorological Research Division, EC, Dartmouth NS
Contact: harold.ritchie@ec.gc.ca

Environment Canada (EC), Fisheries and Oceans Canada (DFO), and the Department of National Defence (DND) require environmental information products and capabilities that can be provided by an operational global coupled atmosphere-ocean-ice data assimilation and prediction system. In-situ data from Argo floats together with other observations permit effective ocean data assimilation. The Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS) including Mercator-Océan participation (France), is providing a framework for research and operations on coupled atmosphere-ocean-ice prediction. Operational activity in CONCEPTS is based on coupling the Canadian atmospheric GEM model with the Mercator system based on the Nucleus for European Modelling of the Ocean (NEMO). The first step for establishing the core system at the Canadian Meteorological Centre (CMC) was to install and validate the NEMO ocean – ice model driven by atmospheric forcing fields provided by the European Centre for Medium-Range Weather Forecasts (ECMWF) as used to produce the operational ocean forecasts at Mercator. Next the CMC GEM atmospheric forcing fields were used in place of the ECMWF fields, and the impact of this change was assessed in a variety of sensitivity and validation studies. More recent developments include the installation of the NEMO ocean data assimilation system (SAM2) and initial coupling of the GEM atmospheric and NEMO ocean-ice models. These latter steps lay the foundation for both one-way and two-way global GEM-NEMO coupled systems at CMC. This talk will provide an overview of these activities, summarize results to date, and discuss plans for new and future operational systems.

3C06.3 ID:3786 14:15

The predictability of tame hay from forcing factors at selected locations in western Canada

Aston Chipanshi , *Richard Rieger* , *David Waldner* , *Harvey Hill*
Agriculture and Agri-Food Canada, AESB
Contact: Aston.Chipanshi@agr.gc.ca

Agriculture is highly sensitive to intra-seasonal, seasonal, decadal and long term climate trends and events. Where the skill exists in predicting the forcing factors that bring about observed weather, significant pay offs can be realized in terms of providing sufficient lead time to plan agriculture activities by making simulations of expected yields using outputs from climate and weather models as inputs. We examine the predictability of tame hay at selected locations in Canada. Locations were selected on the basis that precipitation; the major predictor of tame hay during the growing season can be abstracted from the numerical and statistical forecasts. Using selected locations in western Canada where the ENSO signal appears to affect the winter and summer rainfall amounts, a modest relationship was found between the predicted and observed tame hay yields in ENSO forced years. The variance in the predicted yields can be improved by introducing other explanatory variables such as temperature. The regression based prediction tool can also be used in a near real time setting using the observed climate data and climatology in the absence of a reliable prediction. The use of the tool within a growing season will be demonstrated using a combination of scenario/predicted and climate data.

3C06.4 ID:3580 14:30

An analysis of multiple-model ensemble for seasonal climate predictions

Xiaoqin Yan , *Youmin Tang*
University of Northern British Columbia
Contact: purple_yanxiaoqin@hotmail.com

In this study, we investigated the superiorities of multiple-model ensemble (also called super ensemble hereafter) for seasonal climate prediction, based on four Canadian seasonal climate prediction models, in terms of the deterministic forecast skill, probabilistic forecast skill and the potential forecast skill. The 500mb height prediction is used as the target of seasonal climate prediction in this study. It was found that the performance of super ensemble prediction depends on the prediction region and prediction lead time. Generally, the super ensemble prediction has significant improvements over most individual model ensemble for deterministic prediction skills at mid- and high latitudes. The super ensemble also can produce prediction distribution more consistent with observed climatologic distribution; thereby improving the prediction reliability, especially for the reliability term of BSS (Brier Skill Score). However, the super ensemble only

outperforms a little individual model ensemble for the prediction resolution, due to its limited improvement in the sharpness prediction. Further, the analyses of potential predictability under 'perfect model' assumption were discussed, exploring the possibility in improving seasonal climate prediction through the super ensemble approach.

3C06.5 ID:3928 14:45

Submonthly forecasting of winter surface air temperature in North America based on tropical organized convection

Wenqing Yao [1], *Hai Lin* [2], *Jacques Derome* [1]
[1] Department of Atmospheric and Oceanic Sciences, Mcgill University
[2] Meteorological Research Division, Environment Canada
Contact: yaowq@meteo.mcgill.ca

Using the outgoing longwave radiation (OLR) data as a proxy of tropical convection, the relationship between MJO-related tropical convection and North America winter surface air temperature (SAT) are investigated. Lagged regression between OLR principle component (PC) and SAT shows highly significant correlation over the south-southeast Canada with the strongest SAT anomalies happens at a lag of 2-3 pentads. Lagged temperature composite indicate extensive intensified positive SAT anomaly over southern Canada and northern United States 10-15 days after the above normal convections happened in tropical area. Lagged regressions of 500 hPa geopotential height reveal northeastward wave activities from tropical to North America region. Model simulation with the simple general circulation model (SGCM) reveals eastward propagation of wave activity from tropical ocean area to North America region with anomalies heat forcing added over eastern Indian Ocean and western Pacific, respectively. Using cross-validation technique, a simple regression model is set up to test the forecast skill of taking tropical convective activity as a predictor to forecast winter SAT over North America with results show that a good predicted winter SAT anomaly could be reached in about 10-15 days forecast timescale in of North America area.

When the atmosphere and the ocean get along over the Gulf of St. Lawrence (Part 2) / Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent (Partie 2)

Room / Endroit (Chaudière), Chair / Président (Chris Fogarty), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C07.1 ID:3601 **13:30**

Operational Coupled Atmosphere - Ocean - Ice Forecast system for the Gulf of St. Lawrence, Canada. Update and Evaluation.

Manon Faucher , *Francois Roy* , *Serge Desjardins* , *Pierre Pellerin* , *Hal Ritchie* , *Bertrand Denis*
Environnement Canada
Contact: manon.faucher@ec.gc.ca

A fully interactive coupled atmosphere-ocean-ice forecast system for the Gulf of St. Lawrence (GSL) has been running in experimental mode at the Canadian Meteorological Centre (CMC) for the last three years. The goal of this project is to provide more accurate weather and sea ice forecasts over the GSL and adjacent coastal areas by including atmosphere-ocean-ice interactions in the CMC operational forecast system using a formal coupling strategy between two independent modeling components. The atmospheric component is the Canadian operational GEM model and the oceanic component is the ocean-ice model for the Gulf of St. Lawrence (MoGSL). The coupling of those two models is achieved by exchanging surface fluxes and variables through a coupler developed at RPN.

The coupled system has evolved since its first implementation in 2008. The new features are a radiation scheme from the Canadian Centre for Climate Modelling & Analysis (CCCma) and the introduction of the Charney-Phillips vertical staggering in GEM, a code optimization for MoGSL and a better coupling strategy. The coupled system runs once a day based on 00GMT data to produce operational coupled forecasts. This system, case studies and monthly scores are presented.

3C07.2 ID:3321 **13:45**

Forecasting applications of the coupled gulf modeling system

Chris Fogarty , *Serge Desjardins* , *Garry Pearson*
National Lab for Marine and Coastal Meteorology
Contact: chris.fogarty@ec.gc.ca

Over the past three ice seasons (2008,2009,2010) in the Gulf of St. Lawrence region, forecasters at the Atlantic Storm Prediction Centre and the Newfoundland and Labrador Weather Office have monitored output from the coupled gulf modeling system. The atmospheric component of the system improved over the operational, uncoupled (GEM REG) system with regard to temperature, wind speed, cloud cover, and precipitation. The greatest improvements occur during cold outbreak situations from January to March. A number of specific examples highlighting where the experimental model would have added value to the

forecast will be shown in this presentation. Suggestions for future application of the model in the forecasts (public, marine) are proposed and discussed.

3C07.3 ID:3526 14:00

The influence of wind direction on the coastal impact of the coupled atmosphere-ice-ocean model in the Gulf of St Lawrence. / L'influence de la direction du vent sur l'impact côtier du couplage atmosphère-glace-océan dans le Golfe du St-Laurent.

Tracey Talbot [1], *Serge Desjardins* [2], *Chris Fogarty* [2], *Garry Pearson* [2], *Dan Levy* [3]
[1] National Lab for Marine and Coastal Meteorology, EC,Gander
[2] National Lab for Marine and Coastal Meteorology, EC,Dartmouth
[3] Dalhousie University, Halifax
Contact: serge.desjardins@ec.gc.ca

In recent winter seasons in the Gulf of St Lawrence, operational evaluations of the coupling between the 15 km LAM Regional model and the MoGSL (Gulf of St-Lawrence ice-ocean model) clearly illustrated that the coupling mitigated a cold bias, caused by an overestimation of ice thickness, in the LAM model. Conditional verification statistics have been calculated for various meteorological fields using observations at coastal stations around the Gulf taking into account the effect of wind direction. This study attempts to determine the impact of improved ice field forecasts on airflow over the Gulf of St Lawrence as well as on coastal weather forecasts.

Au cours des dernières saisons de glace dans le Golfe du St-Laurent, les évaluations opérationnelles du couplage entre une version LAM du Régional GEM à 15km et le MoGSL (modèle de glace-océan du Golfe du St-Laurent) ont montré très rapidement que le couplage permettait de corriger un biais froid dans le modèle actuel causé par une surestimation de l'épaisseur de la glace. Des statistiques de vérification conditionnelles ont été calculées pour divers champs météorologiques à partir d'observations météorologiques à des stations côtières alentour du golfe en tenant compte de l'effet de la direction du vent. Cette étude tente de déterminer l'impact de l'amélioration des prévisions de glaces sur la circulation de l'air sur le golfe du Saint-Laurent ainsi que sur les prévisions météorologiques côtières.

3C07.4 ID:3792 14:15

A 3D-Var kilometric scale analysis of conventional data for the deterministic Maritime kilometric GEM-LAM

Luc Fillion , *Monique Tanguay* , *Ervig Lapalme* , *Michel Desgagne* , *Vivian Lee* , *Rick Danielson* , *Stephen Macpherson* , *Jocelyn Mailhot* , *Amin Erfani* , *Anna Glazer*
EC
Contact: luc.fillion@ec.gc.ca

A limited-area 2.5 km 3D-Var analysis for the Maritime GEM-LAM 2.5km model is presented. The formulation of the analysis components (analysis grid geometry, Background-error covariances in Fourier spectral space etc) are presented. We detail the analysis response (through multivariate couplings) using simple observation. We next present typcial analysis increments resulting from full conventional observational datasets and compare some important fields w.r.t the new Regional 3D-Var Reg-Lam response (analysis increments at 100 km and model at 15km). Ongoing work on testing this 2.5 km high resolution 3D-Var analysis system when coupled to the GEM-LAM 2.5 km model for the Maritime region will be presented. The specific impacts of SAR Wind data and Ground based GPS data is currently under examination.

3C07.5 ID:3432 14:30

Assimilation of SAR wind information in Environment Canada's new limited-area 3D-Var analysis system

Rick Danielson , *Luc Fillion* , *Harold Ritchie*
Environment Canada
Contact: Rick.Danielson@phys.ocean.dal.ca

The potential benefit of assimilating synthetic aperture radar (SAR) data into an atmospheric model depends on taking advantage of a SAR's high resolution marine wind information, but this has generally been difficult in conventional assimilation cycles. The challenge lies not so much with the resolution of the model itself, but with the resolution employed when combining observations with a previous forecast to produce the next set of initial conditions (the analysis increments). An appropriate new framework for testing the impact of SAR assimilation is provided by Environment Canada's limited-area variational data assimilation system. Experiments to produce analyses at 2.5-km resolution for the Canadian maritime grid using Radarsat SAR data will be given and steps toward assessing the impact on a model forecast will be described.

3C07.6 ID:3527 14:45

The Cold air Outbreak Index (COI) / L’indice de Poussée d’air Froid (IPAF)

Serge Desjardins [1], *Dan Levy* [2], *Garry Pearson* [1]
[1] National Lab for Marine and Coastal Meteorology, EC,Dartmouth
[2] Dalhousie University,Halifax
Contact: serge.desjardins@ec.gc.ca

The Cold air Outbreak Index (COI) was developed to allow a glimpse of cold air outbreak episodes over the Gulf of St. Lawrence. The COI uses the current wind chill index normalized by this same index calculated with seasonal normal values for a specific station. Combined with the ensemble forecasts, it offers a probabilistic forecast for occurrence of these cold air outbreaks developing behind major winter weather systems affecting eastern Canada. Is COI, in fact, the cold side of a more general index for the Winter Storm probabilistic

detection? Work is underway on this subject. The results of applying the COI to the winter seasons of 2009 and 2010 are presented.

L’Indice de Poussée d’Air Froid (IPAF) fut développé afin de permettre d’entrevoir les épisodes de poussées d’air froid sur le golfe du Saint-Laurent. L’IPAF utilise l’indice de refroidissement éolien actuel normalisé par ce même indice calculé avec des valeurs de normales saisonnières à une station spécifique. Combiné avec les prévisions d’ensemble, il offre alors une prévision probabilistique de la présence de ces poussées d’air froid se développant derrière des importants systèmes météorologiques hivernaux affectant l’est du Canada. Est-ce que l’IPAF n’est en fait que le coté froid d’un indice plus général pour la détection probabilistique de tempêtes hivernales? Des travaux sont en cours à ce sujet. Les résultats de l’application de l’IPAF pour l'hiver 2009 et 2010 sont présentés.

Polar Climate Stability (Part 1) / Stabilité du climat polaire (Partie 1)

Room / Endroit (Capitale), Chair / Président (Guido Vettoretti), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C08.1 ID:3886 13:30

The Role of Antarctica in the Climate System

Andrew Bush
University of Alberta
Contact: andrew.bush@ualberta.ca

The presence of the Antarctic continent, with and without topographic relief, is explored in a set of idealized numerical simulations with a coupled atmosphere-ocean general circulation model. Synoptic-scale changes in atmospheric and oceanic circulations caused by the existence of the continent are described, as well as the interhemispheric influence of the significant Antarctic topography. Antarctica's role in modulating and influencing such phenomena as ENSO, the Antarctic Circumpolar Current, and poleward heat transport are discussed.

3C08.2 ID:4033 14:00

Decadal variability of the Greenland Ice Sheet

Shawn Marshall , *Leanne Wake*
University of Calgary
Contact: shawn.marshall@ucalgary.ca

The Greenland Ice Sheet has been in a state of negative mass balance over the past decade, due to a combination of increased surface melting and increased discharge from marine-based outlet glaciers. The latter effect may be a result of regional ocean warming, or it may represent decadal-scale fluctuations in ice sheet dynamics. Improvements in monitoring of the continental ice sheets reveal that they are more dynamic and variable than expected, so it is important to separate the climate-driven response of the ice sheet from decadal-scale 'ice sheet weather'. We examine fluctuations of the ice sheet surface mass balance and ice dynamics for the last century and make projections for the next 100 years in a model of ice sheet dynamics that includes sensitivity to ocean temperatures, surface meltwater, and high-resolution surface mass balance variations. While the physics that underlie fast flow of marine outlet glaciers are not well-understood or modelled, we consider 'end-member' scenarios in an attempt to place bounds on the rate of retreat of the Greenland Ice Sheet over the coming decades.

3C08.3 ID:3571 14:15

Eddy Diffusivity Associated with the Antarctic Circumpolar Current

Ali Mashayek [1], *William Richard Peltier* [1], *Oliver Bühler* [2], *Raffaele Ferrari* [3]
[1] Dept. of Physics, University of Toronto
[2] Courant Institute of Mathematical Sciences, New York University
[3] Dept. of Earth, Atmospheric, and Planetary Sciences Massachusetts Institute of Technology
Contact: amashaye@atmosp.physics.utoronto.ca

The rate of eddy mixing must be quantified by the assumption of an effective eddy diffusivity in ocean general circulation models. In the past years various studies have led their authors to propose two alternative and conflicting scenarios for the southern ocean. The first of these suggests that the eddy diffusivity should be enhanced in the core of the Antarctic circumpolar Current (ACC) while the second suggests the diffusivity to be more strongly enhanced on the flanks of the ACC. In this study, we demonstrate that the latter scenario is correct through application of a theoretical approach. We show that the difference in the average kinetic energy of the baroclinic eddy fields in the core of the ACC and its flanks along with the meridional variations in the strength of the zonal current lead to the dominance of radiative solutions out of the ACC. These solutions impose enhanced diffusivity on the flanks of the current where the zonal velocity is reduced and close to that of the propagating baroclinic eddies. This demonstrates that the influence of critical layers is profound. Our theoretical results enable prediction of the eddy diffusivity based on introduction of only minimal information from the observations, i.e. latitudinal variation of the zonal current velocity only. The results are found to be in close agreement with estimates of eddy mixing based upon altimetry observations. The enhanced diffusion on the flanks of the ACC repudiates the traditional belief in the oceanographic literature and has critical implications for the parameterizations employed in ocean general circulation models.

3C08.4 ID:3744 14:30

Bi-polar footprints in Eastern Equatorial Pacific sediments during the Last Glacial Period

Nathalie Dubois [1], *Markus Kienast* [1], *Stephanie Kienast* [1], *Claire Normandeau* [1], *Stephen Calvert* [2], *Timothy Herbert* [3]
[1] Dept. Oceanography, Dalhousie University
[2] Dept. Earth and Ocean Sciences, UBC Vancouver
[3] Dept. Geol. Sciences, Brown University
Contact: markus.kienast@dal.ca

This presentation will address climate-related changes in ocean circulation and in planktonic ecosystems in the Eastern Equatorial Pacific (EEP). We obtained multiple proxy records covering the last 100,000 years from four high- resolution sediment cores. These cores are located in three distinct oceanic environments, and thus allow the disentanglement of regional from more localized changes. We use these new records to revisit three hypotheses recently suggested to explain sub-orbital scale variations in the dynamics of the Eastern Equatorial Pacific. In particular, we explore the mechanisms linking millennial- scale changes in sea surface temperature, water column denitrification and surface productivity in the EEP to the timing of northern and/or southern polar climate. This approach lends support to the paradigm that the Southern Hemisphere has a strong influence on the EEP biogeochemistry, via subsurface delivery of nutrients and oxygen. However, fast readjustments of the sea surface temperature responding to Northern Hemisphere climatic conditions occur simultaneously.

3C08.5 ID:3613 14:45

Influence of continental configuration on the formation of a “soft snowball”

Yonggang Liu , *W. Richard Peltier*
Department of Physics, University of Toronto
Contact: ygliu@atmosp.physics.utoronto.ca

We examine the general conditions that must be satisfied by the configuration of the continents in order that steady state solutions for Neoproterozoic climate exist that are characterized by heavy continental glaciation but for which a substantial area of open water in the equatorial region persists. Such solutions have previously been termed “soft snowball” or “slushball” to distinguish them from the “hard snowball” solutions that some have suggested to be required to fit the observational constraints. It is found that three conditions are critical in this regard: (1) the continental area in high latitudes should be large enough that a massive ice sheet may develop even when pCO2 is relatively high, an ice-sheet complex that is subsequently capable of flowing to lower latitude. (2) The continental fragments in low latitude must be connected (or separated only by continental shelves above which water depths are small) to a significant degree with those at higher latitudes. (3) A relatively simple super-continental outline favors the formation of the “soft snowball” state. Although the latter requirement appears to be strict, we have nevertheless found that soft snowball solutions do

exist for the realistic Sturtian continental configuration of Li et al (2009) that existed at ~720 Ma. However, in order for these states to exist the positions of the individual continental fragments must be slightly adjusted so as to improve their connectivity. These adjustments are fully consistent with the error bars on the paleomagnetic inferences of paleolatitude. We also demonstrate that “soft snowball” solutions do not exist in models devoid of active continental ice-sheets capable of flowing over the landscape. These results for Sturtian conditions extend our previously published results for the Marinoan period during which the supercontinent was centred upon much higher latitudes.

The Past, Present, and Future of glaciers in Western North America (Part 2) / Glaciers de l’ouest de l’Amérique du Nord : passé, présent et futur (Partie 2)

Room / Endroit (Pinnacle), Chair / Président (Brian Menounos), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C10.1 ID:3764 **13:30**

Past and future contributions of glacier melt to Columbia River streamflow

R.d. (dan) Moore [1], *Georg Jost* [1], *Valentina Radic* [1], *Faron Anslow* [1], *Alex Jarosch* [2], *Garry Clarke* [1], *Brian Menounos* [3], *Roger Wheate* [3], *Trevor Murdock* [4], *Arelia Werner* [4]

[1] University of British Columbia
[2] University of Innsbruck
[3] University of Northern BC
[4] Pacific Climate Impacts Consortium
Contact: rdmoore@geog.ubc.ca

The Columbia River is the largest river in the Pacific Northwest of North America, with headwaters in both Canada and the United States. It is heavily developed for hydroelectric power generation, and flow releases from reservoirs in Canada are controlled, amongst other criteria, by the Columbia River Treaty, which may be reviewed over the next few years. In support of this process, teams in both Canada and the United States are assessing the potential influence of climate change on water resources. In a study funded by BC Hydro, researchers from the University of British Columbia, the University of Northern British Columbia and the Pacific Climate Impacts Consortium are focusing in particular on the potential effects of glacier response to future climate scenarios. The approach involves the application of a fully distributed glacier dynamics model and a semi-

distributed hydrologic model, each driven by weather variables downscaled from General Circulation Model output. The calibration of the hydrological model is constrained by forcing the simulated glacier mass balance to match volume changes computed from digital elevation models of the glacier surfaces. This presentation focuses on challenges in linking hydrological and glaciological models for simulating transient response and provides some initial results from the hydrological and glaciological models.

3C10.2 ID:3563 13:45

Challenges in modelling heat budgets for steep proglacial streams

R. Dan Moore , *John Richards*
(Presented by *R.d. (dan) Moore*)
University of British Columbia
Contact: rdmoore@geog.ubc.ca

There is increasing concern about the effects of climate change and glacier retreat on stream temperatures. The most rigorous approach to predicting stream temperature response to environmental change is by applying a heat budget model. Drawing upon field studies conducted at Place Glacier, we identify and illustrate critical challenges involved in modelling the heat budgets of steep proglacial streams. These include the need to adjust solar radiation to account for the slope and aspect of the stream and to include the effect of frictional heat generation. Particularly at higher flows, the stream becomes highly aerated. As a result, the albedo of the stream is positively correlated with discharge, standard equations for estimating turbulent transfers are inappropriate, and it becomes difficult to define the stream's width and depth. Given these difficulties in applying a fully deterministic heat budget approach, we apply a hybrid empirical-physical model to simulate downstream temperature changes in the alpine zone below Place Glacier and to assess the sensitivity of stream temperature to changes in stream discharge associated with glacier retreat.

3C10.3 ID:3798 14:00

Validation of a regional glaciation model through remote sensing, western Canada

Brian Menounos [1], *Garry Clarke* [2], *Rob Vogt* [1], *Tobias Bolch* [3], *Erik Schiefer* [4], *Christina Tennant* [1], *Amanda Spendiff* [1], *Roger Wheate* [1], *Etienne Berthier* [5], *Valentina Radic* [1], *Faron Anslow* [1]
[1] University of Northern British Columbia
[2] University of British Columbia
[3] University of Zurich
[4] University of Northern Arizona
[5] CNRS, LEGOS
Contact: menounos@unbc.ca

Numerical models are an increasingly popular tool to predict the fate of glaciers in Earth’s alpine environments. We use remote sensing as one important technique to validate model performance for the UBC regional glaciation model. This model was developed to examine area and volume retreat of many thousands of glaciers in western Canada under future climate change scenarios. The 200 m spatial resolution model solves vertically-integrated, two-dimensional balance equations for mass and momentum. Surface mass balance models use downscaled temperature and precipitation fields that are derived from the NCEP North American Regional Reanalysis (1979 to present at 32 km resolution) and relate the local accumulation or ablation of ice to large-scale climate fields. We compare modeled area, volume, and surface velocity changes to measured changes derived through sequential analysis of digital elevation models and surface displacement techniques using co-registered, optical imagery. The imagery used for our analysis includes aerial photography, and satellite imagery (ASTER, SPOT, Landsat, and Formosat) with repeat acquisition times that vary from days to years. We discuss the skill of the UBC regional glaciation model to simulate changes of select glaciers in western Canada during the twentieth century. We also consider how discrepancies between the model and the remotely-sensed glacier changes can be used to identify and improve model performance.

3C10.4 ID:3454 14:15

Projections of the ongoing and future deglaciation of southwestern Canada

Garry Clarke , *Faron Anslow* , *Valentina Radic* , *Alexander Jarosch*
Earth & Ocean Sciences, University of British Columbia
Contact: clarke@eos.ubc.ca

According to the World Glacier Monitoring Service, rates of ice loss from mountain glaciers have been increasing since the mid 1980s and the “ongoing trend of worldwide and rapid, if not accelerating, glacier shrinkage ... may lead to the deglaciation of large parts of many mountain ranges in the coming decades.” The glaciers of southwestern Canada are no exception to this global trend and their likely disappearance will have substantial impacts on human activity in the affected regions and beyond. By combining GCM projections of climate to 2100 AD with sophisticated approaches to downscaling of temperature and precipitation fields we conclude that, for all plausible emissions scenarios, the present rapid deglaciation of western North America will continue and that ice loss at 2100 AD will be substantial. Using climate-forced ice dynamics simulations to resolve individual glaciers at a scale of 200 m we project the changes in the volume and extent of mountain glaciers that will result from projected changes in climate in southwestern Canada.

3C10.5 ID:3889 14:30

Regional Model Results for Southern Alaska with Implications for Future Changes in Glacier Equilibrium Line Altitudes

Andrew Bush
University of Alberta

Contact: andrew.bush@ualberta.ca

Possible changes in glacier extent and mass balance in the mountains of western North America are important to quantify, particularly for those regions that rely heavily on glacier meltwater for freshwater resources, power, and ecological stability. Previous studies have focused on glaciers in mid-central British Columbia and Alberta using results from both a coupled atmosphere-ocean general circulation model and a regional climate model. Here, similar results will be shown for the mountainous region of southern Alaska and how the climate is expected to change under a moderate emissions scenario of the Intergovernmental Panel on Climate Change. Changes in orographic precipitation, caused by a combination of changing wind speed/direction, atmospheric specific humidity, and precipitation type will be discussed with implications for changes in the equilibrium line altitude of glaciers in this region.

Acoustics in Oceanography / L'Acoustique dans l'Océanographie

Room / Endroit (Bytowne), Chair / Président (Len Zedel), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C11.1 ID:3975 INVITED/INVITÉ 13:30

Acoustics and sediment dynamics: Advancing the state of the art

Alex Hay
Dalhousie University
Contact: alex.hay@dal.ca

Among the least understood aspects of ocean physics is the dynamic interaction between the mobile seabed and the overlying water. The principal driver of this interaction is the shear stress exerted on the bed by the flow of fluid above. Difficulties with respect to prediction arise because: (1) the bed, being granular and highly dissipative, does not respond in a manner that is simply proportional to the applied stress; (2) the active adjustment of the bed results in bedforms exhibiting a range of patterns and scales which is both fascinating and perplexing, which then feedback on the flow via the associated changes in the apparent bed roughness to modify the stress. In the ocean, an additional difficulty not encountered in aeolian environments, is the presence of surface gravity waves, which often represent the most energetic component of the forcing, especially in coastal and continental shelf environments and especially during storms, when most sediment transport activity occurs. The added complexities associated with waves are distinctly non-trivial: (a) the turbulent wave bottom

boundary layer is very thin, O(10 cm), and thus inaccessible to conventional instrumentation; and (b) the net transport is the difference between two large transports under wave crest and trough, and is exquisitely sensitive to non-linearities in the wave-induced motions at the bed. Establishing an observational basis against which predictive models of the interaction can be tested and validated has been and remains an ongoing quest internationally. Active acoustic systems have increasingly become the experimental tool of choice, both for imaging the seabed patterns, and for measurements of the vertical structure of the nearbed flow and the turbulent fluxes of sediment and momentum. The presentation will briefly summarize results from recent studies of seabed dynamics during storms, but will then focus on new developments and prospects for the near future.

3C11.2 ID:3521 INVITED/INVITÉ 14:00

Seasonal and vertical variations in emergence behaviors based on acoustic observations in a shallow estuary

Mei Sato [1], *Peter Jumars* [2]
[1] School of Earth and Ocean Sciences, University of Victoria
[2] School of Marine Sciences, University of Maine
Contact: meisato@uvic.ca

Among migrating crustaceans, many species emerge from sediments into the water column at night. Repeated, diel emergence connects benthic and pelagic communities through bidirectional transfer of organic matter and excreted inorganic nutrients. Tidal and diel cycles regulating animal emergence have been particular foci, but field observations capable of simultaneously resolving both cycles are extremely limited. Emergence behavior was monitored in the Damariscotta River estuary, ME, in fall 2005 and summer 2006 to clarify mechanisms of benthic-pelagic coupling. High temporal and vertical resolution was achieved by simultaneously deploying two multifrequency echo sounders (265-3000 kHz) to interrogate the whole water column. Time-series waterfall plots and spectral analysis revealed that emergence patterns observed at 265–420 kHz (frequencies that detect animals larger than mesozooplankton) followed combinations of diel and tidal rhythms that differed with both depth in the water column and season. Mysid shrimp (*Neomysis americana*) are the dominant emergent mesozooplankton at the study site and showed nocturnal emergence pattern in summer. Toward the end of its emergence season in fall, however, its dominant rhythm shifted to semidiurnal (12.4-h period). The timing of major emergence in the fall coincided with low slack tides near the surface but with peak flood speed near the bottom, providing plausible mechanisms of retention and selective tidal stream transport within the estuary. Previous acoustic studies lacking near-bottom data reported emergent mysids to overwhelm the holoplankton in biovolume, but they, too, seriously underestimated mysid abundance because they failed to resolve this high concentration of animals in the lowermost water column. Understanding variability of emergence patterns is an important prerequisite to quantify the effect of spatially and temporally varying

emergence on benthic-pelagic coupling. This study highlights the importance of high temporal and spatial sampling resolution in detecting and understanding components of emergence.

3C11.3 ID:3540 14:15

Finding Fish in Acoustic Doppler Profiler Data from the VENUS Ocean Observatory

Len Zedel
Memorial University of Newfoundland
Contact: zedel@mun.ca

When using Doppler profilers to extract information on fish movements, it is necessary to record data with no averaging and with minimal processing by the recording instrument. Any self contained deployment is therefore limited by the amount of data that must be internally recorded. Cabled observatories eliminate the need for internal recording and therefore provide the potential for data recording rates that are only limited by the acoustic characteristics of the system. An example of these capabilities is provided by analysis of 150 kHz Doppler profiler data from the VENUS Strait of Georgia East Node collected over a three day period in September, 2009. For this instrument, acoustic profiles were collected at a rate of 0.5 Hz in a depth of 170 m with 2 m depth resolution. Backscatter data show the presence of many discrete fish from which the Doppler data are used to extract fish velocities. Both fish and water velocities show a strong tidal signature with the fish moving relative to the water in several depth intervals.

3C11.4 ID:3498 14:30

Turbulence Measurement With Multi-Frequency Coherent Doppler Sonar

Jeremy Dillon [1], *Len Zedel* [1], *Alex Hay* [2]
[1] Memorial University of Newfoundland
[2] Dalhousie University
Contact: jeremy.dillon@mun.ca

Pulse-to-pulse coherent Doppler sonar is a promising tool for measuring near-bed turbulence and sediment transport in energetic environments such as the wave boundary layer. Turbulence measurements, however, are limited by measurement noise caused by pulse-to-pulse backscatter decorrelation, and by the requirement to resolve velocity ambiguity in the presence of measurement noise. Existing methods address noise suppression and ambiguity resolution separately. We present a velocity estimation algorithm that optimally fuses multi-frequency and multi-transducer measurements to simultaneously suppress noise and resolve velocity ambiguity. Data fusion is achieved using a probabilistic approach, whereby measurements are combined numerically to derive a velocity likelihood function evaluated on a discrete grid. Maximum A Posteriori (MAP) estimation is used to produce a velocity time series in which measurement noise is suppressed while high frequency turbulent fluctuations are retained. Results are presented from a towing tank grid turbulence experiment where both velocity ambiguity and backscatter decorrelation are present. Time series and spectra from MAP velocity estimation are compared to those obtained with conventional Doppler signal processing. In addition to robustly resolving velocity ambiguity, the MAP velocity estimator is shown to lower the noise floor in measured turbulence spectra.

3C11.5 ID:3590 14:45

A weak-scattering model for high-frequency backscattering from oceanic pycnoclines

Tetjana Ross [1], *Andone Lavery* [2]
[1] Dalhousie University
[2] Woods Hole Oceanographic Institution
Contact: tetjana@dal.ca

Sound scattering from oceanic pycnoclines is generally considered to be negligible for acoustic frequencies above about 10 kHz. This is likely a safe assumption in many circumstances. However, recent work has shown that is it not universally true. Strong scattering from the sharp pycnocline associated with diffusive-convection interfaces has been observed in both the laboratory and the field. Though relatively rare, these very sharp pycnoclines are at one end of a continuum of pycnocline sharpness. Here, by generalizing the weak-scattering model developed for diffusive-convection interfaces to apply to most oceanic pycnoclines, we create and apply a tool to determine under which conditions sound scattering from pycnoclines can be significant relative to other sources of scatter in the water column.

Health Issues of Weather and Climate / Conditions météorologiques et climat : effets sur la santé

Room / Endroit (York), Chair / Président (Denis A. Bourque), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C12.1 ID:3411 13:30

Modelling skin temperatures of a human exercising in an outdoor environment

Jenni Vanos , *Jon Warland* , *Terry Gillespie* , *Natasha Kenny*
University of Guelph

Contact: vanosj@uoguelph.ca

Concern over the rise of urban air temperatures and decreased physical activity has illuminated the importance of outdoor human comfort modelling during exercise, and associated physiological and psychological mechanisms. Thermal comfort (TC) models attempt to predict what a human 'feels' in a given environment. The lack of accurate predictions in actual thermal sensation (ATS) reported by individuals is a weakness in modelling, attributed to individual psychological and physiological differences. Magnitude of change in mean skin temperature, as well as conflicting contributions from local skin temperature and internal core temperature also exist. The aim of this study is to verify and improve the accuracy of skin and core temperature predictions in the COMFA (COMfort FormulA) outdoor model to reduce errors in energy budget predictions. Field tests were conducted on subjects performing 30 minutes of steady-state physical activity (running or cycling). The predicted thermal sensations (PTS) from the COMFA budget model using both predicted (with model) and actual (measured) skin temperatures were compared in 5 minute intervals. Results indicate that the model increasingly over-predicted skin and core temperatures throughout the exercise period; hence, the model was less able to accurately predict temperatures as metabolic activity increased. The Spearman's correlation coefficients showed ATS votes correlated more strongly with PTS by the model. Additionally, ATS votes correlated more strongly with PTS scores in running tests, showing that cycling responses were more difficult to predict. These results show the inherent difficulty of using TC models during exercise due to added psychological and physiological variables. More accurate modelling is needed, and can be applied to climate sensitive urban design for creation of thermally comfortable outdoor urban spaces. These are needed to provide more satisfactory spaces for exercise and/or recreation activities, which in turn can increase health and well-being of urban dwellers.

3C12.2 ID:4026 13:45

Potential climate change impacts on the human health

Amir Mohammad Yadghar [1], *Maryam Nadimi* [2]
[1] Concordia University
[2] University of Montreal
Contact: a_yadgha@encs.concordia.ca

Climate change, global warming, heat stress, sea level rise, drowning, water and soil salinization and ecosystem disruption are among the mechanisms that impact on human health. Global temperature is projected to increase by 1.4 and 5.8 °C over the period 1990 to 2100, as well as a predicted rise of 40 cm in the sea level by the 2080s. Extremes of the tropical cyclones, floods and droughts are estimated to increase with temperature change. Three categories of health impacts may be caused by climatic conditions: direct impacts of weather and climate variability; impacts caused by environmental changes that arise in response to climate variability and change; and impacts resulting from

consequences of climate-related economic disruption and environmental conditions. Flooding by coastal storm surges causes an increase in the risk for a number of people from the current 75 million to 200 million in the period of mid-term climate changes. Evidences show that changes in the regional climate system have already affected human health, including mortality from extreme heat, cold, drought or storms; changes in air and water quality; increase in air pollutants concentrations; exposure to air pollutants; and changes in the ecology of infectious diseases. This paper first discusses some issues regarding the factors that affect climate-health association, and uncertainties about climate impacts on health. Then, it aims to review the empirical studies regarding the relationship between climate change and human health, and modeling works of anticipated health risks associated with future climate change.

3C12.3 ID:3820 14:00

Long-term trends in snowfall-related crash risks and potential implications for road weather services

Jean Andrey [1], *Derrick Hambly* [1], *Brian Mills* [2]
[1] Dept. of Geography & Environmental Management, University of Waterloo
[2] Adaptation & Impacts Research, Climate Research Division, Environment Canada
Contact: Brian.Mills@ec.gc.ca

This study explores whether automobile travel during winter weather has become more or less risky over the past two decades. The analysis is based on the integration of two government databases and a matched-pair framework as a basis for estimating casualty collision risks in Canadian cities during snowfall and other winter weather. Results indicate that the relative risk of a casualty collision during these conditions has not changed significantly over time, although there is some indication that the difference in crash rates between dry/clear conditions and heavier snowfalls may be increasing. Thus, winter precipitation remains a serious safety issue, despite system-wide reductions in casualty rates. These findings are in contrast to rainfall-related risks, where both relative and absolute rates have been declining. Implications for road weather services are discussed.

3C12.4 ID:4050 14:15

Sensitivity Analysis of an Integrated Air Quality Health Metric

Amir Hakami
Carleton University
Contact: amir_hakami@carleton.ca

Air pollution in Canada results in thousands of premature deaths every year. Quantitative estimations of air pollution health effects are at best uncertain. However, such quantitative estimates are necessary for decision making as well as for public awareness. Recently, an Air Quality Health Index (AQHI) was introduced to provide an integrated measure of adverse health effects of air pollution. In this work, we will evaluate the sensitivity of the proposed AQHI to

precursor emission sources at all locations and times. To do so, we will use the adjoint version of the community multiscale air quality (CMAQ) model of the USEPA for backward (adjoint) sensitivity analysis. Backward sensitivity analysis allows for simultaneous calculation of the sensitivities of the integrated metric with respect to all model parameters such as emissions. The result of the analyses would be the contribution of different individual or aggregated emission sources (e.g., emission sectors) to the overall AQHI or to the “unhealthiness” of the atmosphere. Our focus will be on the gas-phase components of the AQHI (i.e., Ozone and Nitrogen Dioxide) but future work will also include aerosols. We will also evaluate sensitivities of the AQHI to temperature as a measure of its partial sensitivity to a changing climate.

3C12.5 ID:3687 **14:30**

Forecasting Wind Chill in the Prairie and Northern Regions of Canada

Jason Knight , *Bradley Vrolijk*
Meteorological Service of Canada, Environment Canada, Winnipeg, Manitoba
Contact: Jason.Knight@ec.gc.ca

The Prairie and Arctic Storm Prediction Centre must forecast, warn, and monitor a variety of extreme winter weather events, including such high impact weather as heavy snowfall, freezing rain and blizzard events. But surprisingly, in each of the 2007-2008 and 2008-2009 winter seasons fully 54% of all issued public warnings were wind chill warnings. This high proportion of a single warning type raises concern about the best balance between public safety, public awareness, forecaster workload, and forecasting ability for this issue.

To investigate further, we have extracted wind chill data from the Canadian National Climate Data and Information Archive for 366 currently operating weather stations in Alberta, Saskatchewan, Manitoba, Nunavut and the Northwest Territories dating as far back as 1953. In our ongoing research, we explore the current distribution of wind chill warning events from both a site-by-site and regional perspective. The impact of varying warning threshold values for temperature, wind speed and duration is assessed. We present statistics detailing the impact of each proposed set of criteria upon both the forecaster and the general public.

We also highlight major issues discovered in our research that limit the ability to measure and forecast wind chill, including the precision and accuracy of on-site measurements, wind and temperature forecasting skill, and several of the assumptions built-in to the wind chill model itself. We conclude with several potential solutions that can ease or eliminate some of the concerns outlined above.

Climate Change and Extreme Events (Part 2) / Le changement climatique et les évènements extrêmes (Partie 2)

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Chad Shouquan Cheng), Date (03/06/2010), Time / Heure (13:30 - 15:00)

3C14.1 ID:3332 **13:30**

Development of Multisite Statistical Downscaling Model and Projection of Future Temperature Extremes over Montréal, Canada.

Dae Il Jeong [1], *André St-Hilaire* [1], *Taha Ouarda* [1], *Philippe Gachon* [2]
[1] INRS-ETE, Université du Québec
[2] Adaptation and Impacts Research Division, Environment Canada
Contact: dae_il_jeong@ete.inrs.ca

Realistic projections of future climate scenarios of a targeted local area are essential for assessment of climate change impacts for development of adaptation strategies for water resources management. Statistical downscaling models are broadly used to generate local scale surface meteorological scenarios from global scale atmospheric GCM variables. In this study, a statistical downscaling (SD) model was developed for simultaneous downscaling of daily maximum and minimum temperatures (Tmax and Tmin) for multiple observation sites. The SD model employed Multivariate Multiple Linear Regression (MMLR) for simultaneous downscaling of daily Tmax and Tmin to multiple observation sites and added stochastic randomization procedure to reproduce unexplained natural variability and overestimated spatial dependency by the MMLR on the predictands. The developed SD model was then applied to project future daily Tmax and Tmin scenarios of ten observation sites in the Montréal region. Impacts of climate changes on extreme events on the projected future temperature scenarios were then analyzed. As GCM predictors, CGCM3.1 A1B and A2 scenarios (2061-2100) were employed. Projected series from CGCM3.1 A1B and A2 predictors are compared to observed temperature series from 1961 to 2000. Monthly mean of daily Tmax and Tmin were increased 3.1 and 3.0℃ on CGCM3.1 A1B future scenarios while they were increased 3.9 and 3.7℃ on CGCM3.1 A2 future scenarios from 2061 to 2100. Future temperature series showed higher increase in winter than in the other seasons whereas natural variability of the series decreased in winter. Diurnal temperature ranges of future series showed some increase only in spring and autumn. Future temperature series yielded 21~25 days lower values for the forest season length and 24~27 days higher values for the growing season lengths than observation.

3C14.2 ID:3756 **13:45**

Daily Temperature and Precipitation Extreme Indices as Simulated by Different Regional Climate Models over Canada

Milka Radojevic [1], *Philippe Gachon* [2], *Hyung-Il Eum* [3], *Philippe Roy* [3], *René Laprise* [4], *Van-Thanh-Van Nguyen* [5]
[1] AIRS/Climate Research Division/EC and GEC3 at McGill University
[2] AIRS/Climate Research Division/EC and GEC3 at McGill University and ESCER at UQAM
[3] ESCER at UQAM
[4] ESCER at UQAM and GEC3 at McGill University
[5] Department of Civil Engineering and Applied Mechanics, McGill University
Contact: milka.radojevic@mcgill.ca

Due mainly to their coarse-scale resolution, Atmosphere-Ocean Global Climate Model (AOGCM) simulations cannot be used to address regional or local-scale extreme phenomena. Hence, regionalization techniques, such as Regional Climate Models (RCMs) and Statistical Downscaling (SD) methods, are needed in order to develop high-resolution climate information and to infer plausible changes in climatic extremes. In this study, the ability of RCMs to reproduce extreme indices of daily temperatures and precipitation are evaluated over various regions of Canada with respect to observed gridded ones (ANUSPLIN), and those derived from the North American Regional Reanalysis (NARR). The focus is over the recent past period (1961 to 2008) using RCM's simulations from the Canadian RCM (CRCM) versions 3 and 4, and those from the NARCCAP project (http://www.narccap.ucar.edu/). Results suggest that the downscaling performance over the baseline period significantly varies between RCMs and over various seasons, while the majority of models produced quite similar median values of temperature and less systematic for extremes. For precipitation, more differences and/or less convergence are present between RCMs with higher uncertainties in the downscaled values in that case.

3C14.3 ID:3338 14:00

Drought indices over Canada as simulated by a statistical downscaling model: current and future periods

Rabah Aider [1], *Philippe Gachon* [2], *Grace Koshida* [2]
[1] escer-uqam
[2] environnement canada
Contact: rabah.aider@mail.mcgill.ca

The objective of the present study is to generate from a statistical downscaling tool, local precipitation and temperature daily information to develop drought indices (i.e. the Standardized Precipitation Index, SPI and the Palmer Drought Severity Index, PDSI) for both the current and the future periods over various areas of Canada. Twenty weather stations located in major agricultural regions and transboundary watersheds are used for the study. The downscaling model is calibrated and validated over the current period using reanalysis predictors, whereas for the climatic scenarios runs, three series of global climate model predictors are used (i.e. the Canadian CGCM3 and the UK HadCM3) for both the

A2 and B2 SRES emission scenarios. The results show that for the majority of stations a consistent increase with time in negative SPI and PDSI indices and in the maximum amount of consecutive dry days (CDD), at both seasonal and intra-annual timescales, suggesting more frequent dry and extremely dry periods over the Canadian Prairies. For few stations in eastern Canada, the main changes imply only consistency between models or between drought indices, and not between both. This study has the potential to increase the confidence in the projected signals and its utility in agriculture and in environmental impact and adaptation studies, as some convergent or consistent changes appear between models, and drought indices at various locations across Canada.

3C14.4 ID:3497 **14:15**

After the flames are out: Catchment-scale effects of wildfire on runoff and flow regime in the Canadian Rocky Mountains.

Uldis Silins [1], *Kevin Bladon* [2], *Sarah Boon* [3], *Micheal Stone* [4], *Monica Emelko* [4], *Chris Williams* [1], *Michael Wagner* [1]
[1] University of Alberta
[2] Thompson Rivers University
[3] University of Lethbridge
[4] University of Waterloo
Contact: uldis.silins@ualberta.ca

Increased frequency and severity of wildfires in western North America can be considered an early manifestation of climate change in this region (Westerling et al 2006). The Southern Rockies Watershed Project was established shortly after the 2003 Lost Creek wildfire to describe initial effects, and early recovery of a broad range of watershed “values” in the high water yielding region of Alberta’s Southern Rockies. The research area located near the Crowsnest Pass (AB) encompasses 7 large instrumented watersheds including burned (3), burned & salvage logged (2), and unburned watersheds (2). The present study describes changes in runoff dynamics and the streamflow regime over a five year period (2004-2008). Greater snowpack accumulation (135-420 mm additional SWE) and increased radiation loading advanced the onset of the melt period and increased the magnitude of streamflow from burned watersheds. Onset of melt in the burned watersheds was advanced by approx. 14-24 days though the date of 1st major snowmelt peak was advanced by only 2-3 days across the 5 years of study. Similarly, half-flow dates (when 50 % of annual streamflow has been generated) were advanced by 5-7 days. The general effects of the burn on shape of the mean annual hydrograph similar to those reported for harvested landscapes in snowmelt dominated regions illustrating the 1st order controls of snowpack processes on flow regime of this region. Most notable changes reflect increased water production on the rising limb of the annual hydrograph, with little change in timing on the recession limb. Using matched streamflow “events” (58 matched flow events 2004-2008), the mean magnitude of peakflows from burned watersheds was approximately 110% greater than those evident in unburned watersheds across a range of event sizes. Differences in peakflows between

burned and reference catchments were similar for both for melt generated and rainfall generated events.

3C14.5 ID:3530 14:30

Possible Impacts of Climate Change on Snowfall under Downscaled Future Climate Conditions: An Application to Ottawa, Ontario

Chad Shouquan Cheng [1], *Baoling Wang* [2]
[1] Meteorological Service of Canada Branch, Environment Canada
[2] Science & Technology Branch, Environment Canada
Contact: shouquan.cheng@ec.gc.ca

The overarching purpose of this study was to project changes in the occurrence frequency and intensity of future daily snowfall events under downscaled future climate conditions over Ontario, Canada. The 55-year historical data, including hourly/daily meteorological observations, were used to develop daily snowfall simulation models. In addition, nine GCM outputs with two IPCC scenarios (A2 and B1) were used in the study for future two-time windows (2046–65, 2081–2100). The GCM control runs (1961–2000) were also used to correct the GCM biases. Different regression methods were used to construct downscaling transfer functions for different meteorological variables. Using downscaled GCM meteorological variables, automated synoptic weather typing integrated with cumulative logit and non-linear regression analyses was applied to project future daily snowfall amounts. Downscaling transfer functions and snowfall simulation models were validated using a cross-validation scheme and comparing data distributions and extremes derived from downscaled GCM control runs and observations over a comparative time period 1961–2000. The results showed that the models for all variables used in the study performed well. This talk will introduce the research project and outline the modeling exercise and verification process. The major findings on future snowfall projections from the study will be summarized in the presentation as well. One of the major conclusions from the study is that the methods used in the study are useful for climate change impact analysis on future snowfall.

POSTER Cloud-Aerosol Interactions / AFFICHE Interactions nuages-aérosols

Room / Endroit (Terrace / Terrasse), Chair / Président (Philip Austin), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0202.1 ID:4065 15:30

Impeded ice nucleation in glassy and highly viscous aerosol particles: the

role of water diffusion

Thomas Peter [1], *Bernhard Zobrist* [1], *Ulrich Krieger* [1], *Beiping Luo* [1], *Vacharaporn Soonsin* [1], *Daniel Lienhard* [1], *Claudia Marcolli* [1], *Analia Pedernera* [2], *Thomas Koop* [2]
[1] ETH Zurich; Switzerland
[2] Bielefeld University, Germany
Contact: thomas.peter@env.ethz.ch

In situ and remote observations in the upper troposphere have revealed the existence of water vapour pressures up to and even above water saturation. Under such conditions rapid ice nucleation and growth are expected. While the highest measured supersaturations might not withstand rigorous quality checks, values up to water saturation seem to occur, and the question arises why the pre-existing aerosols refrain from nucleating ice. The atmospheric aerosol is a complex mixture of various inorganic and organic components, with the organic fraction often representing more than 50% of the total aerosol mass. The homogeneous ice nucleation threshold was established for atmospherically relevant salt solutions and sulfuric acid, but only for a few organic species. We show that the organic aerosol fraction may form highly viscous liquids. When the viscosity of such liquids reaches values in the order of 1e12 Pa s, the molecular motion slows dramatically and the sample vitrifies at the glass transition temperature. If aerosol particles were present as glasses, this would lead to a high impedance to water uptake from the gas phase and inhibit ice nucleation. We therefore measured hygroscopicity cycles of aerosol particles with an electrodynamic balance (EDB) at temperatures between 220 – 291 K and developed a microphysical model to calculate diffusion coefficients of water within the particles based on the EDB results together with available literature data. As model substance we chose sucrose, a substance that has been identified in biomass burning aerosols and may represent the high molecular weight constituents of the organic aerosol fraction. We indeed observed a hysteresis between water uptake and release for levitated sucrose particles that is due to slow water diffusion within the glassy particle and can be used to derive water diffusion coefficients at low temperatures with our microphysical model.

POSTER Air Quality and Atmospheric Chemistry from Space to the Boundary Layer / AFFICHE Qualité de l’air et chimie de l’atmosphère de l’espace à la couche limite

Room / Endroit (Terrace / Terrasse), Chair / Président (John C. McConnell), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0203.1 ID:3830 15:30

Determination of Formaldehyde in Ambient Air Using Solid Phase Micro Extraction (SPME)

Visahini Kanthasamy
McGill University
Contact: visahini.kanthasamy@mail.mcgill.ca

Formaldehyde is the highest concentration aldehyde in the atmosphere with typical concentration ranging from 0.3 to 2 ppbv in Canada. It is an important intermediate in the gas-phase methane oxidation chain and plays an important role in the chemistry of troposphere by influencing its hydroxyl radical (HOx) budget, and thus its oxidative capacity. It can be produced anthropogenically and biogenically and can also be transferred from the ocean. Weather the ocean is the source or sink of the formaldehyde is of interest to scientists in order to completely understand the chemical processes happening in the ocean/air. We develop a method for determining formaldehyde in ambient air using solid phase microextraction method (SPME), a facile, low-cost, versatile technique. The formaldehyde is derivatized on the SPME fiber to its pentafluorobenzyl oxime using 1, 2, 3, 4, 5-pentafluorobenzylhydroxylamine (PFBHA) and then analyzed with gas chromatography with flame ionization detector (GC-FID). We herein present the methodology developed, the calibration curves, and some results from outdoor/indoor samplings. We also present an inter-comparison of this method with DNPH derivatization with HPLC method.

3P30-0203.2 ID:3608 15:30

Ottawa Air Quality Information System

Natividad Urquizo [1], *Daniel Spitzer* [2], *William Pugsley* [3], *Martha Robinson* [1]
[1] City of Ottawa
[2] A-MAPS Environmental Inc.
[3] Environmental Consultant
Contact: natividad.urquizo@ottawa.ca

Since 2008, the City of Ottawa has had access to a unique air quality information system. The system comprises new transportable measuring instrumentation, an extended database, a dedicated interactive air quality mapping website and interactive graphical user interfaces for data analyses and health impacts assessments. Concentration levels of NO2, NO, O3, PM2.5 and CO are measured hourly at several locations by monitoring instruments, and then recorded and processed for further mapping of the air pollutant concentration distributions over the entire National Capital Region. Along with local measurements, the mapping process is supported by the data from the National Air Pollution Surveillance network and atmospheric satellite earth observations.

All collected and processed data are then used as inputs into a geospatial model, allowing generation and presentation of hourly air pollutant distribution maps in GIS formats. To interpret the air quality information, a graphical user interface was developed, enabling analyses of the data in terms of standard statistical and custom designed functions such as averaging, max, min, standard deviation, percentiles and critical pollutant level exceedances. Specific time periods and areas can be selected on the interface screen within the mapped region for manipulation and analyses. Results can be then displayed, saved and printed in mapping and text formats and animations. Another recently developed interface is used by the City's decision makers for evaluation of the traffic air pollution impacts in terms of population health risks. To expand and complete the air quality information system, the City's Community Sustainability department is considering further developments, including a specific module of the air quality mapping software, which will provide detailed information regarding air pollution on busy streets.

3P30-0203.3 ID:3826 15:30

The Impact of Meteorology on Air Quality Forecasting in Ontario

Duncan Fraser , *Melynda Bitzos* , *Pamela Fairbridge* , *Phil Kiely* , *Dave Yap* , *Gary De Brou*
(Presented by *Pamela Fairbridge*)
Ontario Ministry of the Environment
Contact: melynda.bitzos@ontario.ca

Meteorology has a significant role on air quality forecasting. Wind and stability are critical meteorological variables that impact air pollutant concentrations as shown in two very distinct occurrences in Ontario. Both scenarios include ozone measurements recorded aloft, 444 m above ground-level at the CN Tower. These measurements are of interest to air quality meteorologists since ozone levels aloft can remain very high overnight as the surface inversion is established and decoupling takes place. One such scenario is shown on the night of June 23, 2003 when the ozone concentrations aloft impacted the surface monitor at Newmarket early the next day. Newmarket, located 45 km north of the CN Tower, at 268 m above sea level (ASL), was very close to the top of the surface boundary layer; therefore, as the nocturnal inversion eroded, the ozone aloft rapidly mixed down to the surface and increased ozone concentrations by 57 parts per billion (ppb) in one hour. In the second scenario, which took place on June 13, 2008, ozone concentrations recorded at the CN Tower were compared to those measured at the air monitoring station located in Toronto Downtown at 105 m ASL. During this occurrence, the elevated ozone concentrations aloft did not mix down and the difference between the 1h ozone maximums was 45 ppb. The lack of vertical mixing may be associated with stability of the air mass and possible inversion in the city. This type of circumstance can provide a challenge for meteorologists forecasting air quality and predicting the occurrence of smog episodes.

3P30-0203.4 ID:4597 15:30

A new objective analysis for surface ozone and PM2.5 for Canadian air quality models

Alain Robichaud , *Richard Menard* , *Yulia Zaitseva*
Environment Canada
Contact: alain.robichaud@ec.gc.ca

Air quality (AQ) models usually suffer from significant biases and random errors for chemical constituents. However, better chemical initialization is possible through objective analysis. In this paper, we develop an OI (optimal interpolation) scheme which combined the GEM-MACH AQ model outputs with US/EPA AIRNOW data base observations for surface ozone and PM2.5. Error statistics for the scheme are prescribed using the Hollingsworth and Lönnberg`s method. Results from the verification (Observation – Analysis: i.e. OmA) of the OI show that OmA averages are strongly reduced and become under 2-5% for ozone and 5-10% for PM2.5. Moreover, standard deviations of OmA with OI are reduced by approximately a factor in the range 1.5-2 as compared to OmP (Observation - Model Prediction). This suggests that the objective analysis is indeed optimal. It is also shown that the accuracy of the OI for surface ozone is not very sensitive to small changes of the error statistics. This scheme will likely be implemented in the operations of the Canadian Meteorological Center in a near future which will provide more accurate analysis available for model initialization and also for AQ meteorologists as a valuable nowcasting tool for surface ozone and PM2.5.

POSTER Aviation Meteorology / AFFICHE Météorologie aéronautique

Room / Endroit (Terrace / Terrasse), Chair / Président (Stewart Cober), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0205.1 ID:3552 15:30

Forecasting long lived fog events along the British Columbia South Coast

Mariette Kulin , *Daniel Waldemaras* , *Sandra Buzza*
Meteorological Service of Canada
Contact: david.whittle@ec.gc.ca

Fog has always been, and continues to be, a serious hazard to aviation. The low ceilings and reduced visibilities that result from the development of fog can have a serious impact on the day to day operations of the aviation community. This is especially true in the southern BC coastal area, which is home to a large number

of VFR operators. During the week beginning January 14th 2009, a rare persistent deck of stratus cloud and fog developed over the South Coast of British Columbia.

Statistically for the month of January at the Vancouver International Airport (YVR), 90% of all conditions in which a ceiling below 400 ft or a visibility less than 1SM is observed, is the result of fog and stratus. An average of about 24 hrs of these Below Alternate (BAL) conditions can be expected each January. What makes the fog event of January 2009 so important is the length of its duration, increasing the total reported hours of BAL conditions at YVR to 212 hours for the month.

This poster examines the key synoptic correlators used by meteorologists at CMAC to predict the onset and dissipation of this rare long lived fog event. The key synoptic correlators that are examined include the orientation of upper level ridges, boundary layer moisture, surface inversion, vapor driven convection and wind conditions. When all of these factors align correctly, as they did in mid January 2009, it is likely that fog will develop and remain until a major shift occurs in the atmospheric pattern. Verification results show that meteorologists at CMAC were able to quickly recognize these factors and effectively forecast the event.

3P30-0205.2 ID:3853 15:30

La prévision du type et de l'intensité du givrage pour l'aviation

Nacera Chergui , *Viateur Turcotte* , *Ronald Frenette*
Environnement Canada
Contact: nacera.chergui@ec.gc.ca

Les principales variables météorologiques qui influencent le givrage en vol sont le contenu en eau liquide des nuages (CEL), la température et la distribution de taille des gouttelettes (MDG) qui déterminent le type et l'intensité du givrage. Les prévisionnistes ainsi que les pilotes doivent distinguer les différents types et intensités du givrage vu le danger associé à chacun pour les avions en vol. Il est utile au prévisionniste de connaître les valeurs typiques des variables reliées au givrage, ces connaissances l'aideront à interpréter les données réellement disponibles pour mieux évaluer et prévoir le potentiel de givrage.

Dans le but de développer un guide de prévision pour le type et l'intensité du givrage, nous avons implanté le nouveau schéma microphysique Milbrandt_Yau dans le modèle de haute résolution Gem-Lam 2,5 km. Les critères utilisés pour les seuils sont basés sur les derniers travaux en R&D dans ce domaine, en particulier ceux de la recherche sur la physique des nuages et du temps sévère et les variables du schème de Milbrandt-Yau. Les avantages de la version actuelle est que le diagnostic tient compte de la convection et fournit une meilleure gradation dans l'intensité du givrage. Les résultats obtenus avec le diagnostic préliminaire basé sur le contenu en eau liquide surfondue (CEL) montrent une nette amélioration de la prévision de l'endroit et de l'intensité (léger, modère, sévère) du givrage par rapport au produit existant.

Le schème microphysique de Milbrandt-Yau à deux moments (incluant la distribution de taille des gouttelettes MDG) a été intégré dans le GEM-Lam 2.5km. Nous avons rajouté un élément essentiel pour diagnostiquer le givrage ce qui nous permettra d'inclure le type du givrage (blanc, mixte, clair). Les valeurs seuils seront ajustées en conséquence.

3P30-0205.3 ID:3811 15:30

A study on the use of weather radar and wind observations to estimate visibility reductions in snow and blowing snow.

Mary Qian , *Bruno Larochelle*
Meteorological Service of Canada
Contact: david.whittle@ec.gc.ca

Reduced visibilities in snow or snow/blowing snow at Canadian airports are a major concern for airline operations. A 1954 empirical relationship between visibility and snowfall rate is revisited and combined with an existing radar relationship between snowfall rate and reflectivity. This yields a relationship between visibility and radar reflectivity:

V = f(Z, thetaW)

where V is the visibility, Z is the reflectivity and thetaW is the wet bulb potential temperature of the airmass.

By looking at a couple case studies, the impact of wind (potential for BLSN) is added to this relationship:

V = f(Z, thetaW, u, v)

where u and v are the surface wind components.

Early results suggest that both relationships may be useful in assisting the operational meteorologist in forecasting reductions to visibilities in a real-time setting. Recommendations are made to combine radar and model output to automatically create SN/BLSN visibility guidance for forecast operations at the Canadian Meteorological Aviation Centre.

3P30-0205.4 ID:3549 15:30

Geospatial Interactive Verification of Thunderstorms (GIVT)

Lindsay Sutton
Meteorological Service of Canada

Contact: david.whittle@ec.gc.ca

Thunderstorms pose safety issues for aircraft, and their potential for disruptions of the air navigation system can lead to significant economical loses. Therefore, it is crucial that thunderstorm forecasts be as accurate as possible.

One way to help improve forecast performance is to provide timely and meaningful feedback to the operational meteorologist. The Canadian Meteorological Aviation Centre (CMAC) has developed the Geospatial Interactive Verification of Thunderstorms (GIVT) to provide such feedback.

The GIVT program compares geospatial output from the Canadian Lightning Detection Network (CLDN) with aerodrome forecasts produced at CMAC. The real-time graphical output is available via an interactive web page which allows users to select the parameters of interest: site, date, and forecast time. This gives users an easy way of visualizing a thunderstorm event, displays how a single forecast performed when compared to recorded data, and shows how the TAFs at a site evolved in the hours preceding an event. Verification is done 24/7 for all TAF sites in Canada.

By providing timely feedback, GIVT maximizes learning opportunities for operational forecasters by capitalizing on recent memories of an event. Forecasters are able to view their TAF performance at any time, and can apply what they learn as early as the next storm.

3P30-0205.5 ID:4599 15:30

The NAV CANADA Automated Weather Observation System - NAV CANADA AWOS - Poster

Faycel Farza
NAV CANADA
Contact: farzaf@navcanada.ca

NAV CANADA is replacing the legacy network of Automated Weather Observation Systems (AWOS) with a new generation of AWOS that is compliant to the Transport Canada exemption to Canadian Aviation Regulations 804.01 (c). Starting with a commercial-off-the-shelf system, which was evaluated for one year with a co-located human observer at Iqaluit Nunavut and St John’s Newfoundland and Labrador, the NAV CANADA AWOS is the result of an extensive effort for algorithm enhancements, implementation of quality assurance processing, and iterative data analysis and testing. In addition to the weather parameters measured by the legacy AWOS it replaces, the NAV CANADA AWOS reports runway visual range, lightning data and density altitude. The NAV CANADA AWOS also features an exclusive remote access capability to monitor the system health and to remotely suppress sensor data. It also interfaces to proprietary systems such as 24/7 monitoring system at Area Control Centres, Air

Traffic Control weather display systems, manned weather observation entry systems and radio weather broadcast systems. The NAV CANADA AWOS reports weather data in BUFR format, based on the world meteorological organization standards, as well as in a comprehensive text stream. It is the only CAR compliant AWOS that generates official aviation routine and special weather observations (METAR/SPECI) from which Environment Canada can produce regulatory compliant aerodrome forecasts (TAF).

POSTER The Vancouver 2010 Olympic and Paralympic Games / AFFICHE Les Jeux olympiques et paralympiques d'hiver de Vancouver 2010

Room / Endroit (Terrace / Terrasse), Chair / Président (G.A. Isaac), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0206.1 ID:3664 15:30

Snow Density Measurement, Whistler Mountain, 1990 to 2010

Mark Barton
Meteorological Service of Canada, Pacific and Yukon Region
Contact: mark.barton@ec.gc.ca

The widespread use of automatic snowfall measurement at Canadian weather stations and the scarcity of manually collected snowfall data has placed limits on our confidence in auto station data. This is especially true in mountainous terrain. Significant differences between manually measured data and auto station data are well documented in World Meteorological Organization (WMO) reports. The use of manually collected snowboard data to ground truth auto data is also well documented by the WMO. Automated west coast alpine snowfall measurements face great challenges during heavy wet snowfall events due to gauge/wind-shield capping. Also, the wind induced weighing gauge under-catch remains a challenge.

Recently digitized manually collected snow board data for Whistler Mountain (1,640 m elevation) from 1990 to 2010 and co-located automatic weather station data from 2005 to 2010 are presented and compared for the overlap period. Multiple changes in auto station snowfall measurement equipment have enhanced the auto station capabilities in heavy wet snowfall conditions. However, one of the adaptations (wind shield removal) has made catch

correction for wind effects more important. The collection of wind speed data at gauge height makes catch correction possible at a future date when the necessary correction factors become available.

The constant changes to automatic weather station equipment, data logger programs and weather station sites collectively present ongoing challenges. This presentation is aimed at illustrating minor successes, ongoing challenges and promoting a dialogue.

3P30-0206.2 ID:3609 15:30

The cloud microphysics scheme in the GEM-LAM - Current and upcoming versions

Jason Milbrandt
Environment Canada (RPN)
Contact: jason.milbrandt@ec.gc.ca

In April 2008, the single-moment version of the Milbrandt-Yau cloud microphysics scheme was implemented into the standard suite of GEM-LAM-2.5 grids, run in quasi-operational mode by the Canadian Meteorological Centre. This grid-scale condensation scheme includes prognostic variables for the mixing ratios of six distinct hydrometeor species: cloud water, rain, pristine ice, snow (large crystals/aggregates), graupel (snow pellets), and hail. Using a combination of the prognostic variables and environmental conditions, 10 different surface precipitation types can be predicted.

In support of weather forecasting by Environment Canada for the 2010 Vancouver Olympics, a special high-resolution (2.5-km and 1-km) configuration on the GEM-LAM was run over the Vancouver-Whistler region. In this set-up, the double-moment version of the microphysics scheme was used. This version of the scheme was also used for a special real-time 1-km forecast grid for the 2008 UNSTABLE project. The double-moment scheme includes an additional prognostic variable, the total particle number concentration, for each of the hydrometeor categories. This allows for a better representation of the evolution of the hydrometeor size spectra and thus a better prediction of the precipitation rates and types.

An overview of the cloud scheme will be provided, with emphasis on new diagnostic fields that are available from the model, including the precipitation types plus experimental fields based on a new technique to predict the instantaneous snow-water ratio directly from the model microphysics. The next upgrade of the GEM-LAM-2.5 system, which is expect to take place some time during 2010, will include implementation of the double-moment microphysics scheme.

3P30-0206.3 ID:4079 **15:30**

Ice fog, blowing snow, and snow properties obtained from GCIP sensor at RND during the SNOW-V10 project

Ismail Gultepe
EC, Cloud Physics and Severe Weather Research Section
Contact: ismail.gultepe@ec.gc.ca

This study will summarize the ground cloud imaging probe (GCIP) observations collected at the Roundhouse (RND) site during the SNOW-V10 nowcasting project. This project took place in the Vancouver-Whistler region during the 2010 Winter Olympics and Paralympics for the period of February to March 2010. In addition to various surface observations of visibility, surface precipitation, wind, and particle type, the ground cloud imaging probe (GCIP) measurements of particle shape and sizes from 7.5 micron up to 960 micron were collected at about 1850 m.

At RND, winter precipitation as snow particles with sizes less than 1 mm occurred at least 50% of time, suggesting that GCIP measurements can be very useful at the locations where light precipitation happens. The GCIP measurements together with LPM and OTT parsivel distrometers measurements can be used for closing the gap of the measurements from sizes less than 500 micron down to 10 micron, and validate the model based precipitation type and rate accurately. The particle type and precipitation amount obtained from the GCIP can also be compared to GEM-LAM based predicted parameters at the surface for nowcasting applications, and new parameterizations can be developed for snow microphysics at cold temperatures. In the presentation, preliminary results obtained from the GCIP sensor will be summarized and discussed for ice fog, blowing snow, and snow conditions.

POSTER Wind Energy / AFFICHE Énergie éolienne

Room / Endroit (Terrace / Terrasse), Chair / Président (Peter A Taylor), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0209.1 ID:3458 **15:30**

Fifty-year return, hub-height, wind speeds

Peter Taylor [1], *Jim Salmon* [2]
[1] York University and Zephyr North Canada
[2] Zephr North Canada

Contact: pat@yorku.ca

Wind turbine manufacturers design machines to survive high wind speeds. If strong winds develop the turbine will be stopped at its cut-out wind speed, typically around 25-30 m/s, and the issue then becomes how strong a wind can it survive in this parked position. Designs take account of maximum gusts but the basic reference point is the 50-year return 10-min average wind speed at hub height, designated as Vref. Wind turbines are generally certified to IEC61400-1 1999 or 2005. These cover requirements for several turbine classes. Which turbine class is appropriate (and cost effective) depends on various factors including Vref . Values of 50, 42.5, 37.5 and 30 m/s are limits for turbines of classes I, II, III, IV. Many large modern turbines are designed to satisfy the requirements for Classes II and III and accurate estimation of Vref becomes essential.

Weibull and Gumbel distributions are used for wind statistics and form the basis for estimations of extreme winds. A limitation is that often only one or two years of site specific, hub height wind data are available when traditional Gumbel methods use annual maximum wind speeds for at least 10 years. Methods based on shorter data sets will be discussed and evaluated noting the issues of whether the data are “independent and identically distributed”. The method of independent storms (MIS) is one option but N-day maximum winds are simpler to deal with. The Bergstrom method, documented in the 1999 European Wind Turbine Standards II document (99-073) appears to give lower estimates than Gumbel projections based on 3-day maxima.

Relative to extreme winds at 10m we can note a narrower distribution (higher Weibull k) at 80m or 100m. which is beneficial.

Ensemble forecasting: current and emerging applications / Prévisions d’ensemble : applications actuelles et émergentes

Room / Endroit (Terrace / Terrasse), Chair / Président (Bertrand A. Denis), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0211.1 ID:3772 **15:30**

Raising the model top for an ensemble Kalman filter system

Seung-Jong Baek [1], *Peter Houtekamer* [1], *Herschel Mitchell* [1], *Xingxiu Deng* [2], *Normand Gagnon* [2]
[1] Meteorological Research Division, Environment Canada
[2] Meteorological Service of Canada
Contact: Seung-Jong.Baek@ec.gc.ca

Recently, the Canadian Meteorlogical Center (CMC) introduced a new, staggered, vertical coordinate for the Global Environmental Muntiscale model. The new coordinate is thought be more accurate and should facilitate raising the model top further into the stratosphere. As a first step, we raised the model top from 10 hPa (~ 32 km) to 2 hPa (~ 43 km) while keeping the horizontal resolution and the number of vertical levels same as before (400 × 200 with 58 vertical levels), effectively resulting in slightly reduced vertical resolution. Since the model top has been raised, it has been necessary to change the statistical description of the model error. We moved to a non-separable description provided by the variational system at our center. With the new statistics we have less spread for the wind component and it is evaluated if adding stochastic parameterization can lead to an appro- priate increase in ensemble spread. Doubling the ensemble size dealt with the small scales near the surface in the new statistics and also with the low correlations with wind in the stratosphere.

POSTER Regional Climate Modelling / AFFICHE Modélisation régionale du climat

Room / Endroit (Terrace / Terrasse), Chair / Président (Laxmi Sushama), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0305.1 ID:3597 15:30

Representation of Thermokarst Lakes in the Canadian RCM

Alex Matveev , *Laxmi Sushama*
Réseau canadien en modélisation et diagnostics du climat régional (MDCR-CRCMD)
Contact: matveev@sca.uqam.ca

This paper will outline a framework for representing intra- and interannual dynamics and carbon flux of thousands of thermokarst (thaw) lakes (TKL) covering Northern Canada and Alaska in the Canadian Regional Climate Model (CRCM5). TKLs have recently become suspected to release more organic carbon than it was thought before. The emissions are predominantly attributed to

the organic-rich sediments previously sequestered in permafrost. It is also suggested that these permafrost-originated emissions will further increase and then decline in concert with the permafrost thaw and the TKL area loss. However, the released amount of organic carbon may provide an important contribution to the local and global carbon budget. Therefore, advancement in model representation of these large areas of open water underlain by up to Pleistocene-aged organic-rich permafrost is expected to improve the representation of hydrological, cryological and biogeochemical processes in cold regions in the CRCM land surface scheme.

POSTER When the atmosphere and the ocean get along over the Gulf of St. Lawrence / AFFICHE Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent

Room / Endroit (Terrace / Terrasse), Chair / Président (Serge Desjardins), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0405.1 ID:3633 **15:30**

Sea ice cover trends in the Estuary and Gulf of St. Lawrence between 1969 and 2008.

Remv Villeneuve , *Simon Bélanger* , *Pascal Bernatchez*
Université du Québec à Rimouski
Contact: remyv@cgocable.ca

The sea ice cover in the Estuary and Gulf of St.Lawrence (EGSL) plays a critical role for the estuarine hydrodynamic and the maintenance of the coastal ecosystems integrity. Here, weekly regional ice charts for the 1969-2008 period covering the EGSL, as archived in a digital format by the Canadian Ice Service, were analyzed to detect regional and local trends in the sea ice cover over the last four decades. Statistical analysis of sea ice cover abundance by concentration and ice type was performed on a 1-km grid and used to establish week-by-week trends in sea ice extent on the St.Lawrence for specific regional and local areas. Spatio-temporal variability in sea ice was then related to various physical forcings. Empirical orthogonal functions (EOFs) were calculated to highlight coupling between wind, temperatures, net solar radiation, precipitations, climatic oscillations, such as the El Nino Southern Oscillation (ENSO) or the

North Atlantic Oscillation (NAO), and variations of sea ice cover types and concentrations over time for specific areas of the EGSL. Prevailing winds and current hydrodynamics have been identified as dominating factors for the establishment of the sea ice cover in the studied region with great influence on spatio-temporal distribution of total concentration and ice thickness. Analysis of the sea ice historical patterns in the context of larger scale climate variations will help support impact studies of climate change on coastal erosion rates at various locations along the EGSL.

POSTER Acoustics in Oceanography / AFFICHE L'Acoustique dans l'Océanographie

Room / Endroit (Terrace / Terrasse), Chair / Président (Tetjana Ross), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0502.1 ID:3351 15:30

An Intercomparison of Acoustic Current Meters Deployed on the Scotian Shelf

Adam Drozdowski , *Blair Greenan* , *John Loder* , *Murray Scotney*
Bedford Institute of Oceanography
Contact: blair.greenan@dfo-mpo.gc.ca

A subsurface mooring was deployed on the Scotian Shelf for the period of 8 May – 3 June 2008 for the purpose of doing an intercomparison of two new acoustic Doppler single-point current meters: the Aanderaa Seaguard and Teledyne RDI Doppler Volume Sampler (DVS). These were compared with both a mechanical current meter (Aanderaa RCM8) and an upward looking Teledyne RDI acoustic Doppler current profiler (ADCP).

An intercomparison of five current meters indicates that all instruments provide a good measure of speed and direction in a shelf environment with moderate flows, with correlation coefficients for each of speed and direction exceeding 0.96 in all cases. Vertical shear in this environment was determined to be a significant source of differences across the 11 m of the water column where the current meters were deployed. It was found that all instruments had high directional differences at low speeds (< 10 cm/s). For speeds less than 5 cm/s, the RMS difference was between 20-45 degrees.

It was found that occasionally very large differences occur between instruments

(in excess of 6 cm/s and 75 degrees). Discrepancies of this magnitude were shown to be of extremely low probability to occur if the differences fit a normal distribution (0.1 % of the time for the speed and 0.5 % for the direction). The source of these extreme differences appears linked to internal wave activity at the mooring site.

POSTER Coastal Oceanography and Inland Waters / AFFICHE Océanographie côtière et les eaux intérieures

Room / Endroit (Terrace / Terrasse), Chair / Président (Guoqi Han, Ram Yerubandi and Jinyu Sheng), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0505.1 ID:4173 15:30

Instability mechanisms and reflection of internal solitary waves shoaling upon coastal boundaries of lakes and oceans

Payam Aghsaee
Leon Boegman & Kevin G. Lamb
Contact: payam.aghsaee@ce.queensu.ca

The instability and breaking of fully nonlinear internal solitary waves shoaling upon a uniformly sloping boundary was investigated using high resolution two-dimensional numerical simulations. The simulations were performed for a wide range of boundary and wave slopes ($0.01 < S < 0.3$). Over steep slopes ($S > 0.1$), three distinct breaking processes were observed; surging, plunging and collapsing breakers which are associated with reflection, convective instability and boundary layer separation, respectively. Over mild slopes $S < 0.05$ nonlinearity varies gradually and fission results from dispersion. The dynamics of each breaker type were investigated and the predominance of a particular mechanism was associated with each breaker type. The breaking location was modeled as a function of wave amplitude (a), characteristic wave length (Lw) and the isopycnal length along the slope (Li). The breaker type was characterized in wave slope (a/Lw) versus S space and the reflection coefficient (R) was modelled as a function of the internal Iribarren number. High Reynolds numbers ($Re > 10^4$) were found to trigger a global instability, which modifies the breaking process, relative to the lower Re case, but not necessarily the breaking location and results in an increase in the reflection coefficient by approximately 10%.

3P30-0505.2 ID:3453 15:30

Quantifying the sensitivity of FVCOM to wind and solar forcing in a fresh water lake.

Jennifer Shore [1], *Ram Yerubandi* [2]
[1] Royal Military College of Canada
[2] National Water Research Institute
Contact: rojo_cinco@yahoo.com

Kingston Basin, a region in the northeastern end of Lake Ontario, sits between the main body of the lake and the outflowing Saint Lawrence River. Its circulation is influenced by three large islands and other bathymetric features as well as its hydrographic location. Thus, to accurately model the flow structure in the basin, a model would necessarily include the entire lake but also have the ability to resolve the smaller scale bathymetric features and coastline within Kingston Basin. We use a finite volume numerical model (FVCOM) to simulate Lake Ontario hydrology with a focus on the Kingston Basin circulation.

Results from a coarse (2394 nodes) and refined (5678 nodes) unstructured model mesh using two vertical resolution schemes (S-type and uniform sigma layer) are presented. The model is forced with daily NCEP wind forcing for the IFYGL years 1986 and 1987 so that model velocities could be compared to IFYGL summer observations in Kingston Basin. Sensitivity tests are also conducted to measure the simulated response to variation in solar forcing. Simulated results are compared to observations of vertical temperature profiles in 2006 collected by the National Water Research Institute.

3P30-0505.3 ID:3914 15:30

Measuring internal-wave energy flux in a partially-mixed estuary

Clark Richards [1], *Daniel Bourgault* [2], *Peter Galbraith* [3], *Alex Hay* [1], *Dan Kelley* [1]
[1] Dalhousie University
[2] Institut des sciences de la mer de Rimouski, Université du Québec à Rimouski
[3] Maurice Lamontagne Institute
Contact: clark.richards@dal.ca

The measurement of energy fluxes mediated by internal waves is fundamental to assessing the role of such waves in mixing. Generally speaking, it is important to account for nonlinear terms, and it can be challenging to isolate wave signals and directions in the presence of complex background flows and hydrographic conditions. We illustrate this in the context of extensive measurements made in the St. Lawrence Estuary in the summer of 2008. The data set is rich, and it provides a good test case for methods of separating waves from background fields that vary rapidly in time and space.

POSTER Environmental Prediction in Canadian Cities / AFFICHE Prévisions environnementales pour les villes canadiennes

Room / Endroit (Terrace / Terrasse), Chair / Président (James A Voogt), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0604.1 ID:3939 **15:30**

A LIDAR-based approach for anthropogenic heat release modeling by buildings at the urban neighborhood-scale

Mike Vander Laan [1], *Rory Tooke* [2], *Andreas Chisten* [1], *Nicholas Coops* [2], *Ron Kellett* [3], *Timothy Oke* [1]

[1] University of British Columbia, Department of Geography / Atmospheric Science Program
[2] University of British Columbia, Forestry, Integrated Remote Sensing Studio
[3] University of British Columbia, School of Architecture and Landscape Architecture
Contact: andreas.christen@ubc.ca

Building construction, urban density, and urban form all influence building energy demand, and ultimately the amount of waste energy (anthropogenic heat flux) that is injected into the urban atmosphere. Clearly, anthropogenic heat injections are neither spatially homogeneously distributed, nor constant in time, and their patterns are challenging to resolve. As many urban form attributes fall within the regulatory domain of local governments, planning policy and regulation in Canadian communities, more detailed information will further assist communities in finding urban form-based strategies to meet challenging energy- and emission-reduction targets.

We will present an approach to calculate neighborhood-scale anthropogenic heat fluxes and energy consumption (of the building component) using automated classification of buildings based on LIDAR data and building energy models. A primarily residential area of 4 km2 in Vancouver, BC has been selected as a test case. The area is chosen to overlap with the source area of a micrometeorological urban flux tower for which multi-year energy balance and climate measurements are available. Further, for this area, a detailed LIDAR-derived digital surface model at 1-m resolution exists.

We use a combination of scaling down and scaling up to quantify the anthropogenic heat flux for a set of idealized building typologies relevant in this neighborhood. Energy-use data is assigned to types based on literature, field surveys and parameters extracted from LIDAR data such as building volumes and form. More than 5000 buildings were automatically classified into different

types. For each type with input from measured consumption statistics and urban climate data, a building energy model was run. Results are compiled to estimate temporal profiles and map spatially resolved anthropogenic heat flux densities from buildings at the neighborhood-scale based on the current condition.

POSTER Micrometeorology of Canadian Ecosystems / AFFICHE Micrometéorologie des écosystèmes canadiens

Room / Endroit (Terrace / Terrasse), Chair / Président (Paul A Bartlett), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0605.1 ID:3781 15:30

Observations of soil respiration in a deciduous mixedwood forest

Paul Bartlett [1], *Ralf Staebler* [1], *M. Altaf Arain* [2], *Kuo-Hsien Chang* [3], *Shannon Brown* [3], *Jon Warland* [3]
[1] Environment Canada
[2] McMaster University
[3] University of Guelph
Contact: paul.bartlett@ec.gc.ca

Soil respiration was measured over three growing seasons in a deciduous mixedwood forest near Borden, Ontario. A single automated chamber was supplemented with occasional manual spatial soil respiration measurements conducted on 30 additional soil collars in the primarily deciduous part of the forest, and on six soil collars in the coniferous part of the forest. The behaviour of soil respiration was evaluated with respect to soil temperature and soil moisture in the deciduous and coniferous areas. Differences in environmental conditions between the years, particularly with respect to soil moisture, resulted in differences in the observed carbon dioxide fluxes from the soil. The response to drying of the soil was initially slow, until the volumetric soil moisture approached 10 percent, after which respiration dropped quickly. Spatial variability and seasonal trends were also examined.

3P30-0605.2 ID:4018 15:30

Multi-year measurements of surface energy fluxes in Canada's Southern Arctic: an examination of the potential consequences of climatic warming

Elyn Humphreys [1], *Peter Lafleur* [2]

[1] Department of Geography & Environmental Studies, Carleton University
[2] Department of Geography, Trent University
Contact: elyn_humphreys@carleton.ca

Arctic ecosystems may exert a number of possible feedbacks on climate change from local to global scales as changes in surface characteristics affect radiation, energy and carbon budgets. This study examines the influence of terrain type (mesic mixed tundra, mesic shrub tundra, sedge fen, and lake) and interannual variability in weather on the surface energy budget of these four ecosystems all located within the same arctic watershed at Daring Lake, NWT, Canada. Albedo differed most between the aquatic and terrestrial ecosystems as lake ice typically remained 2-4 weeks after snow melt on land. During the ice/snow-free growing season, average net radiation was up to 3 MJ m^{-2} day^{-1} less for dry, warm sites, which had higher albedo and greater upwelling longwave when compared to the lake. The proportion of net radiation partitioned into convective fluxes was also dependent upon moisture, ranging from nearly 80% at the drier mixed tundra, to 65% at the fen and only 30% at the lake. Atmospheric heating (the sum of latent and sensible heat fluxes) was twice as large over land than water with only small variations among the three terrestrial ecosystems. Energy partitioning among latent and sensible heat fluxes also varied considerably among sites with daytime Bowen ratios varying from 0.05 (lake) to 0.57 (fen) and as high as 1.45 (mixed tundra). Earlier snow melt and other variations in weather influenced both the absolute energy exchange and energy partitioning. Over the past six years, snow melt date varied by 25 days and latent heat fluxes increased linearly with increasing length of the snow-free period. The range in annual latent heat flux approaches the magnitude of spatial variations in this flux. These results suggest that shifts in vegetation and associated surface characteristics such as canopy conductance, leaf area index, roughness, and albedo expected with climate change will be important.

POSTER Weather and Climate Monitoring in Canada - Current operations and future directions / AFFICHE Monitoring du temps et du climat au Canada - Activités en cours et orientation future

Room / Endroit (Terrace / Terrasse), Chair / Président (Michael Manore), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0609.1 ID:3385 **15:30**

The role of Prairie and Northern in the installation and maintenance of Environment Canada's Atmospheric Monitoring Networks.

Darren Tessmer
Environment Canada
Contact: darren.tessmer@ec.gc.ca

Prairie and Northern Atmospheric Monitoring Section has the overall responsibility for the operation, maintenance and installation of meteorological stations in the region. The data collected from the network is essential for the prepartion of forecasts, warnings, and analysis of longer term climatic changes by meteorologists and researchers. Using a Quality Management System framework Atmospheric Monitoring strives to meet the World Meteorological Organization's targets for data accuracy and availability within Canada's Meteorological Service.

3P30-0609.2 ID:3628 **15:30**

Ensemble Kalman Filter for Soil Moisture Data Assimilation of Brightness Temperatures

Marco Carrera , *Stephane Belair* , *Bernard Bilodeau* , *Sheena Solomon*
Environment Canada
Contact: marco.carrera@ec.gc.ca

To improve the representation of the land-surface in their operational Numerical Weather Prediction models, the Meteorological Research Division of Environment Canada has developed an Ensemble Kalman Filter (EnKF) for the assimilation of soil moisture brightness temperatures. An important first step in determining the optimal configuration of the EnKF prior to operational implementation is to perform a series of evaluation studies within the context of an Observation Simulation Sensitivity Experiment (OSSE). This study reports on the sensitivity and evaluation tests performed with the EnKF. Synthetic brightness temperature observations used in our OSSE are consistent with the configuration (temporal frequency, incidence angle, etc …) of the recently launched Soil Moisture and Ocean Salinity (SMOS) mission. Our evaluation of the EnKF focuses upon approaches to model background errors which are essential to the optimum performance of the EnKF. We examine various methods to perturb both the atmospheric forcing and geophysical fields (albedo, roughness, vegetation fraction, etc…) to generate sufficient ensemble spread among the model members. Additionally, we discuss an approach to perturb the precipitation forcing data which is arguably the most important atmospheric forcing to land-surface models.

Our study will also examine the combination of L-band satellite brightness temperatures with screen-level temperature and relative humidity data for an improved performance of the EnKF within an operational environment.

3P30-0609.3 ID:3739 15:30

Presentation of the Emergency Mobile Surface Weather and Upper Air Station developed by MSC Quebec Region.

Jouni Makkonen
Meteorological Service of Canada
Contact: jouni.makkonen@ec.gc.ca

The Emergency Mobile Weather Station can be deployed quickly whether it be for accidents/disasters or for research. Surface weather instruments and upper air equipment is contained within this unit. Technician will cover some history of past mobile weather stations in Quebec, equipment and technical details plus completed and futur projects.

3P30-0609.4 ID:3863 15:30

The THORPEX observation impact inter-comparison experiment

Ronald Gelaro [1], *Rolf H. Langland* [2], *Simon Pellerin* [3], *Ricardo Todling* [1]
[1] Global Modeling and Assimilation Office, NASA Goddard Space Flight Center,Greenbelt, MD, USA
[2] Naval Research Laboratory, Monterey, CA, USA
[3] Environment Canada, Dorval, Quebec, Canada
Contact: Simon.Pellerin@ec.gc.ca

An experiment was conducted under the auspices of the THORPEX International Working Group on Data Assimilation and Observing Systems (DAOS IWG) to directly compare the impact of all assimilated observations on short-range forecast errors in different operational forecast systems using an adjointbased technique. The technique allows detailed comparison of observation impacts in terms of data type, location, satellite sounding channel, or other relevant attribute. This study describes results for a “baseline” set of observations assimilated for the month of January 2007 by three forecast systems: the Navy Operational Global Atmospheric Prediction System of the Naval Research Laboratory, the Goddard Earth Observing System-version 5 of the Global Modeling and Assimilation Office, and the Global Deterministic Forecast System of Environment Canada. Despite differences in the assimilation algorithms and forecast models, the impacts of the major observation types are similar in each forecast system in a global sense. Large forecast error reductions are provided by satellite radiances, geostationary satellite winds, radiosondes and commercial aircraft. Other observation types provide smaller impacts individually, but their combined impact is significant.

3P30-0609.5 ID:3845 15:30

Wind measurements in Canada

K.a. Devine
Private Instrument Consultant

Contact: ken.devine@sympatico.ca

Wind measurements have been conducted at major weather stations since the nineteenth century and those systems used by the Meteorological Service of Canada (MSC) are examined in detail. The physical characteristics and accuracies of each of the anemometer systems employed by MSC during the twentieth century are shown in this paper. As well some of the errors resulting from their installation and the coding, both human and automated, of the system outputs are presented as is the degree of nation-wide deployment.

3P30-0609.6 ID:4109 15:30

Human Quality Control of MSC Atmospheric Monitoring Networks Data

Anna Deptuch-Stapf , *Tim Read* , *Champa Neal* , *Cheryl Robertson* , *Kim Hsu* , *Chris Kocot*
Environment Canada
Contact: anna.deptuch-Stapf@ec.gc.ca

Meteorological data recorded by variety of meteorological monitoring networks are subject to different quality control procedures depending on their lifecycle and users needs.

This Poster will present the overview of MSC quality control processes and the role of human experts in the archiving of quality Canadian meteorological data. It will illustrate through various examples the role of human expertise, experience and interactions with other quality systems such as the National Montoring Desk improves the quality of data.

3P30-0609.7 ID:4116 15:30

The Big Show: Complexities of running a network of automatic weather stations and associated systems in support of the 2010 Vancouver Winter Olympics.

Pat Wong , *Bill Scott* , *Drew Pawley* , *George Davies* , *Frank Mirecki*
Environment Canada
Contact: pat.wong@ec.gc.ca

Since the bid was awarded in 2004 to Vancouver/Whistler for the 2010 Winter Olympics, the Meteorological Service of Canada has been involved with setting up a network of automated data monitoring and collection systems. Prior to this, the entire area surrounding the Whistler and Callaghan Valley venues as well as areas meteorologically upstream were very data sparse. To complicate matters, much of the area was inaccessible, thickly treed, steeply sloped and exposed to extreme winter weather conditions. Approximately 50 new or upgraded automated systems were installed and operational for the games. While most were available for several winters before the games, there were many last minute requests and even one full station installed on less than one days' notice on the

day of the opening ceremonies. The installations included both platform & tripod based automated weather systems, webcams, a doppler radar and an acoustic wind profiler. To maintain these systems in the extremely harsh climate of the Coast Mountains so that the winter data collection continued as accurately as possible was found to be very complex, especially with the high-pressure of the needs of the individual sports and the world looking on. Data from these stations were critical for weather forecast operations of MSC, other clients include weather modelling, climatological studies, public weather information and the specific requirements of the Olympic sport events. Specific details on the stations, siting, weather, logistics & other challenges encountered in operating such a complex network will be discussed.

3P30-0609.8 ID:4118 15:30

Challenges Involved in Monitoring the Weather in Central and Northern BC.

Jean Deveault , *Jack Bowling* , *Frank Mirecki*
Environment Canada
Contact: pat.wong@ec.gc.ca

Environment Canada's Pacific and Yukon Region is responsible for monitoring the weather for BC and the Yukon from 3 offices; Richmond, Prince George and Whitehorse. Responsibilities of the technical staff include installation, repair and maintenance services for networks such as Surface Weather and Climate, Upper Air, Radar, Marine as well as support for specialized data networks including CAPMoN, Ozone, Solar Radiation, the Olympics and others. Using a Quality Management System framework, EC's Atmospheric Monitoring strives to meet the World Meteorological Organization's targets for data accuracy and availability within Canada's Meteorological Service. This presentation will look at the particular challenges of a technical services officer based in Prince George BC

POSTER Polar Climate Stability / AFFICHE Stabilité du climat polaire

Room / Endroit (Terrace / Terrasse), Chair / Président (Guido Vettoretti), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0704.1 ID:3748 15:30

Alkenone paleothermometry: New insights from culture studies and eastern tropical Pacific surface sediments

Markus Kienast , *Grace Macintyre* , *Ainsley Hill* , *Nathalie Dubois* , *Claire Normandeau*

Dept. Oceanography, Dalhousie University
Contact: markus.kienast@dal.ca

Reconstruction of past ocean and climate conditions from marine sediments relies on proxies, measurable descriptors of past environmental conditions preserved in the sedimentary record. One such proxy is alkenone unsaturation, expressed as the UK37 index. Alkenones are synthesized mainly by a specific group of marine phytoplankton called coccolithophorids, and their degree of unsaturation has been established to be intimately linked with mean annual sea surface temperatures (maSST) during coccolithophorid growth. However, recent studies have hinted at a seasonal bias of coccolithophorid growth and/or non-thermal effects, such as salinity or nutritional status, to also affect alkenone unsaturation, possibly explaining subtle deviations from the tight linear correlation between maSST and UK37. Here we present new results from culture studies and a compilation of UK37 in surface sediments from the eastern tropical Pacific. Together, these data sets suggest that salinity has no significant effect on alkenone unsaturation. On the other hand, strong seasonality in coccolithophorid growth, such as observed in the upwelling region off Peru, does appear to skew the sedimentary UK37 record toward warmer SSTs during the non-upwelling season.

3P30-0704.2 ID:3570 15:30

Diatom assemblages present in surface sediments of Baffin Bay, Davis Strait and Labrador Sea

Megan Goudie , *Marianne Douglas*
University of Alberta
Contact: mgoudie@ualberta.ca

The oceanic region flanked by the Canadian Arctic Archipelago and Greenland has recently gained global interest as the future seasonal existence of arctic sea ice has been put in doubt. This region experiences annual fluctuation in sea ice. Algal communities, comprised primarily of diatoms, undergo rapid assemblage succession in the presence or absence of sea ice. The study of such change in assemblages over time can be used to determine changes in sea surface conditions, including sea ice. The goal of this study is to describe basic diatom communities present in the Baffin Bay region by analyzing diatom assemblages in the surface sediments. The results will determine whether diatoms represent a suitable proxy for sea ice cover in the Baffin Bay to Labrador Sea area. Fifteen marine surface sediment samples from the North Water polynya, Baffin Bay, Davis Strait, Jones Sound, Lancaster Sound, and the Labrador Sea were studied to describe differences in diatom species assemblages. The samples were cleaned using hydrochloric acid, followed by hydrogen peroxide to remove carbonate and organic material, respectively. The resulting siliceous slurries were mounted on coverslips and examined using light microscopy, while scanning electron microscopy was used to supplement the identification of diatom species. Diatoms were preserved in all 15 samples. Three hundred

diatom frustules were counted for each sample. A large proportion of the diatom communities in the Labrador Sea, Davis Strait and southern Baffin Bay is dominated by centric diatoms, while the more northern sites are characterized by pennate diatoms. This difference in communities may represent the transition from subarctic to arctic conditions. Diatom taxa indicative of sea ice presence were found in all samples; however, the diversity and abundance varied among regions. The results of the study demonstrate the potential usefulness of diatoms as a proxy for sea surface conditions in this area.

POSTER IPY and Related Atmospheric, Oceanographic, and Hydrological Studies / AFFICHE AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie

Room / Endroit (Terrace / Terrasse), Chair / Président (William Allan Perrie), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0706.1 ID:3503 15:30

Carbon Monoxide (CO) photoproduction from particulate and chromophoric dissolved organic matter in the southeastern Beaufort Sea

Guisheng Song , *Huixiang Xie* , *Simon Bélanger*
Université du Québec à Rimouski
Contact: sgsheng0301@gmail.com

Carbon monoxide (CO) photoproduction from particulate (Ppom) and chromophoric dissolved organic matter (Pcdom) was determined in the southeastern Beaufort Sea in August 2009. Filtered (0.2-μm) and unfiltered surface and deep-chlorophyll-maximum (DCM) seawater samples were irradiated at 3.5°C with simulated solar radiation that was screened by successive long-band cutoff filters. The absorbed photons-based efficiency of CO production from both CDOM (Ecdom) and POM (Epom) decreased with increasing wavelength across the ultraviolet and visible regimes but Epom was far greater than Ecdom in the visible. At the surface Ecdom decreased from near-shore to offshore while Epom trended oppositely; Ecdom was higher than Epom. At the DCM Ecdom remained relatively invariable while Epom increased from land to sea; Ecdom was lower than Epom. Epom at the DCM was on average 9 times that at the surface. Under full-spectrum irradiation Ppom contributed 12 and 20% to total

CO production in surface and DCM samples, respectively. This study provides the first dataset of wavelength-dependent Epom spectra and demonstrates that (1) Ppom is a significant component of CO photoproduction in the Arctic Ocean; (2) with respect to CO production, marine POM is more photoreactive than its terrestrial counterpart whereas the opposite is true for CDOM; (3) pigments-depleted detrital materials are less photoreactive than pigments-enriched phytoplankton cells.

3P30-0706.2 ID:3818 15:30

Cluster analysis of source-receptor relationships of Arctic air mass using AMS measurement data and Lagrangian modeling

Richard Damoah , *Asan Bacak* , *James Sloan*
UNIVERSITY OF WATERLOO
Contact: rdamoah@uwaterloo.ca

The Arctic is characterized by a low aerosol load; however, aerosol concentration increases considerably in late winter and spring (Arctic haze) and during direct advections of polluted air from lower latitudes in other seasons. Nearly all pollution in the high Arctic originates from more southerly latitudes. Local pollution sources are small and limited to the vicinity of the Arctic Circle. Long-range transport of air pollutants to the Arctic is observed mostly in winter and spring, when the southward shift of the Arctic front facilitates the advection of polluted air from mid-latitudes, mainly from Europe and Asia.

Clustering of back trajectories has been widely used for the analysis of atmospheric composition measurements at fixed observatories and has been found to be an efficient method for separating air masses with different properties. Contrarily to single back trajectories, the use of clustering technique based on Lagrangian Particle Dispersion Model (LPDM) accounts for atmospheric turbulence and convection, however, very few studies have used LPDM clustering technique as a tool for source-receptor analysis. In this study we have used a year-long (2007) AMS dataset (comprising sulfate and organic aerosols) taken at PEARL (80oN, 86oW) and clustering technique based on FLEXPART (LPDM) footprints to answer the following questions: (1) Can we identify in our data the contribution to sulfate and organic concentrations from European, North American and Asian anthropogenic sources predicted by models? (2) Is it possible to identify contributions from forest fires or from other types of biomass burning? (3) To what extent can we explain the seasonal variability in sulfate and organic aerosol concentrations at PEARL by variations in atmospheric transport patterns?

3P30-0706.3 ID:3843 15:30

Particle Effective Radii Calculated from Measurements in the High Arctic

Christopher Perro , *Graeme Nott* , *Jonathan Doyle* , *Colin Pike-Thackray* , *Thomas Duck*

Dalhousie University
Contact: christopher.perro@gmail.com

Effective radii for particles are measured using the CANDAC RMR Lidar (CRL) in the High Arctic at Eureka, Nunavut (80N, 86W). It is located at the Polar Environment Atmospheric Research Laboratory (PEARL) and is part of the assembly of instruments in the Canadian Network for the Detection of Atmospheric Change (CANDAC). The CRL emits laser light in the ultraviolet and visible spectrums while collecting backscatter from particles and molecules at seven different wavelengths. Measurements of color ratio with Mie Scattering Theory are used to calculate effective particle radii at varying altitudes. The results are compared with the Arctic High Spectral Resolution Lidar (AHSRL) and Millimeter-wave Cloud Radar (MMCR) results from an earlier study. The CRL's greater sensitivity to smaller particles provides new information on smaller particles that the MMCR was not sensitive enough to detect. The results have implications for cloud properties, radiative transfer, and the dehydration greenhouse feedback.

3P30-0706.4 ID:3921 15:30

Temperature and Precipitation Changes in SE Alaska and SW Yukon, 1949 – 2006.

Colleen Mortimer , *Tyler Sylvestre* , *Luke Copland*
University of Ottawa
Contact: colleenmortimer@gmail.com

This study reports on climate trends at six meteorological stations located on either side of the Wrangell – St. Elias Mountain range over a 57 year period (1949 – 2006). Average temperature (°C), freezing degree days (FDD), positive degree days (PDD), total precipitation (mm), snowfall (mm SWE), and the ratio of snowfall to precipitation (SP ratio) were analyzed for three maritime (Juneau, Yakutat and Valdez) and three continental (Gulkana, Burwash Landing and Whitehorse) locations.

Our findings indicate that site-specific increases in temperature of up to 0.063°C yr^{-1}). at Burwash Landing (1967-2006) were greater than those previously reported by regional-scale studies. In particular, intense winter warming was observed at continental stations. At Gulkana the rate of winter warming was nearly 3 times greater than the annual rate of warming, which has resulted in a significant decrease in FDDs in the winter (6.709°C yr^{-1}).

We find the ratio of total snowfall to total precipitation (SP ratio) to be an important indicator of climate related warming at maritime stations. At Juneau and Yakutat total precipitation increased, but the SP ratio decreased in both winter and spring. This indicates that a much greater proportion of precipitation is now falling as rain, rather than snow, along the coast of SE Alaska as winter temperatures rise above the freezing point. Comparison with indices of synoptic-

scale climate variability indicate a strong relationship between the observed changes in maritime locations and the strength of the ENSO, PDO and PNA indices.

3P30-0706.5 ID:3931 15:30

Hydrological and Geochemical Responses of Arctic Tundra Lakes to Climate and Landscape Perturbation: Overview and Preliminary Results

Erika Hille [1], *Daniel Peters* [2], *Fred Wrona* [2], *Steven Kokelj* [3]
[1] Department of Geography, University of Victoria
[2] Environment Canada, Water and Climate Impacts Research Centre, University of Victoria
[3] Water Resources Division, Indian and Northern Affairs Canada
Contact: ehille@uvic.ca

A number of lakes in the lake-rich, upland region east of Inuvik, Northwest Territories have been impacted by permafrost degradation (i.e. active layer thickening and landscape slumping). These freshwater ecosystems are projected to be impacted by climate change and resource development in the upcoming years. As the climate continues to warm, the north-western Arctic is projected to be impacted by increasing rates of permafrost degradation, which is projected to increase the geochemical loading to these lakes. The overall goal of this study is to investigate the impact of permafrost slumping on lake water quality/quantity near the proposed Mackenzie gas pipeline. This study will focus on data collected from two paired lakes (one with a hillslope retrogressive thaw slump and one with no permafrost degradation) collected over a multi-year period. The goal of this project is to present preliminary results linking seasonal variability in the geochemistry of the lake to the landscape using samples taken from snow, surface run-off and subsurface runoff from the spring freshet in April to freeze-up in early October. In addition, the hydrology of the lake will be investigated through examination of water budget components, such as snowmelt and rainfall input, loss via evaporation, outflow from the lake and change in storage. Investigating the impact of permafrost “slumping” on geochemical loading to freshwater ecosystems is important to determining the affects of permafrost degradation as a result of climate change and resource development on the hydro-bio-geochemistry of these ecosystems. This poster will provide a project overview with some preliminary hydro-climatic and geochemical results.

3P30-0706.6 ID:3716 15:30

Spatial variation of ice motion across Devon Ice Cap, Nunavut, Canada

Wesley Van Wychen [1], *Luke Copland* [1], *Laurence Gray* [2], *Dave Burgess* [3], *Brad Danielson* [4], *Martin Sharp* [4]
[1] University of Ottawa
[2] CCRS/NRCan
[3] NRCan
[4] University of Alberta
Contact: wvanw046@uottawa.ca

SAR speckle tracking of RADARSAT-2 images acquired throughout March 2009 is used to create ice motion maps for all of Devon Ice Cap. In situ dGPS data collected throughout 2008 and 2009 are used to validate these velocity patterns. These speckle tracking results provide the first velocity results for the entire Devon Ice Cap which are unaffected by satellite look direction problems associated with previous studies utilizing SAR interferometry. Results are compared with those of Burgess et al (2005), who determined ice motion maps for the ice cap in the mid-1990s using ERS 1/2 data. The present study increases the accuracy and resolution of the earlier results, and enables an evaluation of whether ice motion has changed over the last ~15 years. Additionally, a comparison between the earlier results of Burgess et al (2005) and the present study may aid in the identification of possible surge type glaciers on Devon Ice Cap.

POSTER Uncertainty in climate change impacts to the water cycle / AFFICHE Incertitude quant aux effets du changement climatique sur le cycle de l'eau

Room / Endroit (Terrace / Terrasse), Chair / Président (Katrina Bennett), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0802.1 ID:3618 15:30

Response of Arctic lake ice to changing climate: historical trends and future scenarios.

Silvie Harder [1], *Terry Prowse* [1], *Yonas Dibike* [1], *Terry Callaghan* [2]
[1] Water and Climate Impacts Research Centre/ University of Victoria
[2] Abisko Scientific Research Station
Contact: silvikistan@gmail.com

Various model simulations show that there will be a noticeable amount of latitudinal variation in rates of climate change with climatic changes predicted to be accelerated in the Arctic in comparison with the rest of the globe. Average Arctic temperatures are forecasted to rise at twice the rate as the global mean due primarily to the albedo effect and changes in oceanic circulation patterns with most warming occurring in the winter. Hydrologic systems in the Arctic are particularly sensitive to climate change, especially as nearly all high latitude hydrological processes are influenced by snow and ice processes. Lake ice responds quickly to climatic warming and is valuable in the investigation of climate change and variability. Changes to ice cover such as earliest freeze-up date and latest break-up date, ice cover duration and maximum ice thickness reflect changes in winter air temperature. These changes to freshwater ice provide an early indication of the potential environmental and social significance of climate change and could have extensive ecological and economical implications. There have been numerous studies and modelling attempts looking at trends in lake ice and climate. Most of these studies are based on short-term records as there are few sites with detailed long-term records of climate and lake-ice data. This data scarcity is especially true for high latitude lakes where very few long-term ice records exist. Sweden has been observing ice cover and composition changes as well as related meteorological conditions at Lake Torneträsk (68°21'N, 18°49'E) for over a century. The detailed climate and ice data from Lake Torneträsk is serving as a test bed site where the MyLake (multi-year lake simulation) model has been calibrated and is being used to make future projections of how climate change may affect lake ice in the circumpolar north under different future climate scenarios.

3P30-0802.2 ID:3694 15:30

Bigger pipes or greener communities: A hydrological assessment of using low impact development to mitigate flooding under future climate scenarios.

Chris Jensen [1], *Daniel Peters* [2]
[1] University of Victoria
[2] Water & Climate Impacts Research Centre
Contact: Chris.Jensen@gov.bc.ca

The purpose of the research is to determine if Low Impact Development (LID) can effectively mitigate flooding under projected future climate scenarios. LID relies on runoff management measures that seek to control rainwater volume at the source by reducing imperviousness and retaining, infiltrating and reusing rainwater. Examples of LID include green roofs, pervious pavements and infiltration swales. In addition to flood mitigation, two other benefits of LID are: i) potential reduction in costs required to upgrade engineered drainage systems, ii) protection of downstream watercourse geomorphology, aquatic habitat and water quality. There is a large gap in the literature regarding the use of LID as an effective adaptation approach for reducing climate change impacts. The hypothesis is that smaller urban watersheds (i.e. less than10 km2) can achieve adequate flood protection by strategically employing LID measures. This premise will be examined via three objectives: i) determine the effectiveness of LID in reducing flooding risk, ii) establish the selection of LID measures that provide the highest degree of flood mitigation, and; iii) determine the relative extent and makeup of LID treatments needed to offset projected runoff scenarios. Downscaled regional climate models are used for future climate scenarios. The Bowker Creek Watershed, located in Victoria, British Columbia, is being used as a case study. A tangible outcome of the proposed research is to determine if LID can be used as a viable alternative to conventional drainage infrastructure. The software XP-SWMM is being used for the hydrotechnical assessment. The anticipated significance of the research is in identifying a preferred approach for adapting to climate change, both within the unique case study area and potentially, in similar rainfall-dominated, urbanized watersheds around the globe.

3P30-0802.3 ID:3802 15:30

Modeling precipitation uncertainty effect on flood flows in a medium sized watershed

Phillip Mutulu [1], *Rod Blais* [2]
[1] Manitoba Water Stewartship
[2] University of Calgary
Contact: blais@ucalgary.ca

Water resources managers are increasingly facing the challenge of assessing the impacts of potential climate changes on floods. While significant effort has been made to investigate climate uncertainties and their impacts on hydrology, a gap still exists in understanding how uncertainties inherent in modeling individual hydrometeorologic processes influence flood hydrograph simulation. One such process is the excess precipitation which is critical in determination of a flood hydrograph. A popular method used to model excess precipitation is the loss accounting method of Natural Resources Conservation Service Curve Number (NRSC-CN).

This study investigates elasticity theory based sensitivity of flood flows to uncertainties in precipitation when NRSC-CN is applied to compute flood runoffs. An alpine watershed, James River watershed in southwestern Alberta, has been chosen as a case study in this investigation. Historical daily data and simulations from the Canadian Coupled General Circulation Model (CGCM1) are used to drive the HEC-1 model to generate ensemble of flood hydrographs using Monte Carlo simulations. Uncertainties in precipitation are then investigated to estimate their effect on flood runoff hydrographs.

Results indicate that the change in flow rate with recurrence intervals between 2 and 200 years is more than 1.2 times the corresponding change in precipitation depths. An important observation is that the NRSC-CN does realistically show that the simulated flood flows are elastic with respect to precipitation depth, i.e. changes in the latter generate amplified changes in the former.

POSTER Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction / AFFICHE Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides

Room / Endroit (Terrace / Terrasse), Chair / Président (John Pomeroy), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0803.1 ID:4074 15:30

Avoiding the field capacity question: Determining retained soil moisture on a hillslope using fundamental soil physics and topography

Ric Soulis , *Guoxiang Liu* , *James Craig*
Civil and Environmenral Engineering University of Waterloo
Contact: rsoulis@uwaterloo.ca

An important characteristic of a distributed hydrologic model is its representation of the sub-grade processes. It has become common practice to organize the calculations of the energy and water balances on a landcover basis and to treat the watershed as a contiguous collection of categorized landscape elements. These supply runoff to micro drainage systems that in turn deliver water to major drainage systems. The storage/runoff characteristics of these elements have a direct influence on land surface processes including evaporation, infiltration, surface runoff, interflow, and recharge. Part of the Canadian modelling effort is to identify the key processes occurring in the elements for varying landscape types and how to best incorporate the conceptualization of each process into mathematical models. In many cases, soil drainage processes are represented using a series of sloping soil layers that are subject to infiltration, percolation, and downslope interflow. To be successful, such an approach requires a means to calculate the distribution of retained water in the sloping soil horizons as a function of time. Traditionally soil moisture is represented by conceptually sound but somewhat arbitrary functions. For example, retained water was first unconstrained in WATDRAIN, the soil moisture module in MESH. Then, in WATDRAIN2, field capacity was used as a limit, defined as the water remaining in the soil when suction is at one third atmosphere. In both cases MESH had difficulty in dry conditions.

A new approach is proposed for near-surface flow based on an approximate analytical solution to Richard's Equation for a sloped aquifer for both saturated

and unsaturated conditions. The results are compared to simulations using a one-dimensional fully-implicit Crank-Nicolson finite-difference scheme. The impact of the approach on simulated hydrographs is demonstrated. The long term soil moisture estimates are compared with conventional field capacity values.

POSTER Classification, modeling, and inter-comparison studies of environmental controls on catchment hydrologic response / AFFICHE Classification, modélisation et études comparatives des mécanismes de contrôle environnementaux sur la réaction hydrologique des bassins versants

Room / Endroit (Terrace / Terrasse), Chair / Président (Ilja Tromp-van-Meerveld and April James), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0804.1 ID:3629 15:30

Hydrogeomorphic landscape classification and storage-discharge dynamics in a Boreal Precambrian Shield catchment

Claire Oswald [1], *Murray Richardson* [2], *Brian Branfireun* [1]
[1] University of Toronto (Mississauga)
[2] Carleton University
Contact: claire.oswald@utoronto.ca

As part of a whole-ecosystem mercury addition experiment, a 7.5 ha zero-order Precambrian Shield catchment was intensively monitored from August 2007 to October 2008 to characterize its hydrological and biogeochemical behaviour across a range of wetness conditions. Hydrometric and geochemical observations were used in combination with a detailed depth-to-bedrock survey and digital terrain analysis to examine spatio-temporal dynamics in catchment storage, hydrologic connectivity, and event runoff response. Using a 1m resolution LiDAR digital elevation model, the landscape was partitioned into unique elements on the basis of local drainage conditions. These landscape elements were subsequently classified using various quantitative indices of slope, contributing area, and vegetation characteristics to provide a framework in

which to investigate water storage dynamics. The storage dynamics in different elements follow a predictable trajectory based on their topographic setting and local drainage conditions. Connecting midslopes and ridge tops quickly transmit water to depressional elements that then control the delivery of water to downslope areas through a fill-and-spill process of hydrologic connectivity. During rain events the runoff response is controlled by antecedent storage deficits generated within depressional elements having deeper soil depths and poorer drainage conditions. In particular a large depressional area located at the bottom of the catchment covering 10% of the total area ultimately controls the runoff response at the outlet such that when the water table falls below the elevation of the downslope bedrock sill the flow of water ceases. This combined analysis of subsurface hydrology and topographic structure provides further insight into how different landscape elements contribute to the hydrologic functioning of Shield dominated catchments, and provides a promising scaling framework for quantifying storage-discharge dynamics in these topographically complex landscapes.

3P30-0804.2 ID:4002 15:30

Hydrologic connectivity and geochemical signature during a rainfall event in a forested watershed

Caroline L'Heureux
Département de géographie, Université de Montréal
Contact: caroline.lheureux@umontreal.ca

Determining the hydrological flow paths in a watershed remains a challenge. Recently, the concept of hydrological connectivity has been applied to investigate and assess the spatial and temporal distribution of wetness in a watershed and the potential of various areas of a watershed to convey water. One problem with the application of connectivity is the difficulty to obtain measures that conclusively establish the state of moisture in the soils of the watershed. In this paper, we present measures of the water table before obtained during and after a rainfall event in a small forested watershed of the Canadian Shield. The experiment took place in the Hermine, a 5 ha headwater basin with shallow soils and an impervious level at about 75 cm below the surface. The watershed has a relief of 31 meters with an intermittent stream at the bottom of an east-west valley. A network of 94 wells covering the whole basin has been installed to monitor the level of the water table. Wells were inserted as deep as possible below the soil surface. Discharge is measured at the outlet of the basin every 15 minutes. Antecedent conditions were dry and only 27% of the wells mostly near the valley bottom contained some water just before a rainfall event of 32 mm that fell over 12 hours. The hydrograph peaked at the end of the rainfall period and the event lasted 38 hours. Samples of stream water were collected every hour during the hydrological event to measure the concentration of the major ions. The level of the water table in the wells was measured seven times from the beginning to the end of the hydrograph. At the peak of the hydrograph, only eight wells did not respond and a clear pattern of near surface saturation developed at

the bottom of the valley but also along two zones that extend for long distances on the neighboring hillslopes. These two zones connect the stream to areas that are at a distance of 80 meters or more upslope from the valley bottom. This quick response of the water table on the hillslope is reflected in the stream water composition as the signature shifts from organic horizons in the vicinity of the stream at the beginning of the storm to a major contribution from the upslope mineral soil horizons at peak flow. This study shows how quickly complex but well organized connectivity patterns develop to control the stream water volume and composition. The process of spill-and-fill from pockets in the impervious layer under the soil surface controls part of the stream response to rainfall even when antecedent moisture conditions are dry.

3P30-0804.3 ID:3446 15:30

Ecohydrological linkages between water quality and aquatic ecology after severe wildfire in Rocky Mountain catchments

Kevin Bladon [1], *Uldis Silins* [2], *Monica Emelko* [3], *Micheal Stone* [3], *Sarah Boon* [4], *Chris Williams* [2], *Mike Wagner* [2], *Evan Esch* [2], *John Spence* [2]
[1] Thompson Rivers University
[2] University of Alberta
[3] University of Waterloo
[4] University of Lethbridge
Contact: kbladon@tru.ca

The Southern Rockies Watershed Project (SRWP) was initiated in 2004 following the Lost Creek wildfire, a severe wildfire burning approximately 21,000 ha in the headwaters of the Oldman River Basin, Alberta. SRWP was established to document the immediate impacts of wildfire and post-fire salvage harvesting on watershed-scale hydrologic and ecological functions, and to assess watershed recovery. Total suspended sediment (TSS) was strongly affected by disturbance, with mean concentrations 8-times greater in burned and 9-times greater in salvage logged watersheds compared to unburned watersheds. During the first post-fire year various forms of nitrogen (N) were 2- to 7-times higher in burned streams compared to unburned streams. While mean concentrations of NO3-, DON, TDN, and TN recovered rapidly after the fire, higher inputs are still evident. Watershed disturbance resulted in 2- to 13-times greater mean annual concentrations of all forms of phosphorus (P) compared to reference streams. Particulate P comprised the dominant form of total P; therefore coupled P and sediment interactions are likely implicated in slow P recovery. Post-fire nutrient inputs have resulted in large increases in primary productivity, with 7- to 14-times more periphyton biomass and 17- to 71-times more chlorophyll a in burned streams compared to reference streams. Consequently, there were strong differences in benthic macroinvertebrate community structure after the fire, including higher invertebrate densities, shifts in species composition, and increased species diversity in the disturbed watersheds. Stable isotope analysis (carbon and nitrogen) of macroinvertebrates indicated greater use of the available autochthonous resources (internally derived periphyton) in the

disturbed streams, suggesting potentially complex ecohydrologic interactions between post-fire biogeochemical pathways and biological responses regulating the structure of aquatic food webs. Thus, wildfire and post-fire salvage logging can produce a series of ecohydrological effects from water quality impacts as drivers to increased stream productivity at several trophic levels.

3P30-0804.4 ID:3393 15:30

Hot spots and hot moments of DOC export in a subarctic peatland catchment.

David Olefeldt , *Nigel Roulet*
McGill University
Contact: david.olefeldt@mail.mcgill.ca

In the Stordalen catchment, located in subarctic Sweden near Abisko, we studied from snowmelt to late autumn, the application of the ‘hot moments and hot spots’ conceptualization to the source areas and transport of dissolved organic carbon (DOC). The catchment is dominated by birch forest, permafrost peatlands and arctic heath above the tree line. A secular trend in increasing temperatures and winter precipitation have lead to a rapid loss of permafrost in the lowland peatlands suggesting that there might be an increase in peatland generated DOC and as a result a change in the overall quality of the exported DOC. Discharge and DOC samples from 8 different sites within the catchment enables the assessment of the relative importance of each major landscape unit in determining their relative importance in the quantity and quality of DOC export

Higher DOC concentrations were found in water leaving the peatlands and from the surface layer of the birch forest but these source areas only became connected to the streams during periods that corresponded to periods of high discharge, either in response to large inputs and/or minimal storage capacity.

A positive relationship between DOC quality, as determined by specific UV absorbance (SUVA), and discharge was found indicating that during times of high discharge, when the peatlands were hydrologically connected to the streams, a lower quality DOC was exported. However, this general relationship changes over the seasons and is different for each landscape unit. Lakes are found to play a role in modifying the quality of DOC as it is pass through them as flow moves downstream.

3P30-0804.5 ID:3491 15:30

Towards understanding runoff generation controls: modeling a catchment as a mosaic of linear and nonlinear contributing sources

Geneviève Ali , *André Roy*
Département de géographie, Université de Montréal
Contact: genevieve.ali@umontreal.ca

Identification of runoff generation controls remains challenging, in part due to largely unknown scale-dependent thresholds and nonlinear relationships between catchment internal state variables (e.g. soil moisture) and discharges monitored at the outlet. Here we focus on the temporal connection between point-scale soil moisture, meteorological conditions and watershed response, with the objective of building a parsimonious model of dominant hydrological processes. We work in a small forested catchment where soil moisture has been measured at 121 different locations at four depths on 16 occasions. Without making any assumption on active processes, we aim to determine the potential of each monitoring location to represent a significant active (i.e. sensitive to antecedent conditions) and contributing (i.e. linked to discharge) source. Hence, for each of the 121 sites, we use first, second and higher order polynomials in order to find the mathematical model which best describes the relationships between point-scale soil moisture, antecedent conditions and catchment discharge. We then map the nature of the "best fit" model to identify spatial clusters of soil moisture monitoring sites whose hydrological behaviour is similar. While some catchment areas are linearly correlated with antecedent conditions or discharges, some others rather share a quadratic or a higher order relationship with these variables, thus revealing a mosaic of linear and nonlinear catchment contributing sources controlled either by surface or subsurface topography. Soil moisture measured at depths less than 15 cm is involved in nonlinear relationships with catchment discharges, while soil moisture measured at 30 and 45 cm rather shares a linear relationship with overall watershed response. These results represent a step forward in developing a hydrological conceptual model for our catchment as they indicate depth-specific processes and triggering conditions. They also highlight the ability of a simple method to detect which catchment areas are mainly responsible for streamflow generation.

3P30-0804.6 ID:3553 15:30

Comparison of the relationships between antecedent wetness indices and runoff response for four small experimental catchments

<u>Ilja Tromp-van Meerveld</u> [1], *Daniele Penna* [2], *Hilary Mcmillan* [3], *April James* [4]
[1] Simon Fraser University
[2] Universita di Padova
[3] National Institute of Water & Atmospheric Research Ltd
[4] North Carolina State University
Contact: ilja@sfu.ca

Many processes and threshold responses in hydrological systems are dependent on soil moisture, and therefore hydrologists studying individual storm events rely on estimates of soil moisture conditions to inform their interpretation of catchment behavior. Despite recent advances in soil moisture monitoring techniques, data is not always available to determine actual catchment wetness conditions. Even when soil moisture data is available for one or several locations, it is difficult to determine the actual catchment wetness which depends on the spatial variability in soil moisture. Instead, hydrologists often use 'antecedent wetness indices' which estimate moisture conditions using proxy variables such as rainfall. The objective of this study was to determine how well the actual antecedent moisture conditions are reflected by the commonly used indices and to compare the relationships between soil moisture and runoff response for four small experimental catchments. The catchments are located in Georgia (USA), Quebec (Canada), Northern Italy and New Zealand, and represent a range of climates and hydrologic regimes. We analyzed the relationships between actual catchment wetness as measured by in-situ soil moisture sensors and calculated antecedent wetness indices The antecedent wetness indices used were the 3, 7 and 14 day normalized antecedent precipitation indices, the 3, 7 and 14 day antecedent precipitation, streamflow at the start of the rainfall event, and groundwater level in the riparian zone at the start of the event. Results show very poor, multi-valued relationships between the precipitation-based antecedent wetness indices and actual soil moisture: this is largely due to the strong annual cycles of soil moisture which are not captured by the indices. Streamflow shows a strong, although highly non-linear, relationship with soil moisture and hence has value for comparison and prediction of runoff response.

POSTER Forest Hydrology and Water Management / AFFICHE Hydrologie forestière and gestion des eaux

Room / Endroit (Terrace / Terrasse), Chair / Président (Paul Egginton), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-0806.1 ID:3672 **15:30**

Effect of Wildfire on Ground Level Energy and Water Balance in a Forested Peatland: Do Trees Act as Net Water Conservation Agents?

Dan Thompson [1], *Brian Benscoter* [2], *Merritt Turetsky* [2], *Mike Waddington* [1]
[1] McMaster Centre for Climate Change, McMaster University
[2] Dept. of Integrative Biology, University of Guelph
Contact: jmw@mcmaster.ca

In the forested continental bogs of western Canada, wildfire serves as the primary agent of disturbance, affecting c. 1500 km2 per year. We examine the contrast in surface-level energy and water exchange in both mature forested and post-fire peatlands with no living tree canopy (treeless). Compared to treeless post-fire peatlands, surface level (1m) net radiation was reduced by approximately 40% in the proximity to spruce tree clusters. Negative net radiation values were recorded during mid-day, indicating a large reduction in energy

available for evaporation and the ground heat flux. Moreover, albedo of more shade-tolerant species such as lichens is higher compared to either Sphagnum fuscum (hummock microform) or S. angustifolium (hollow microform). Both measured evaporation and the vapour conductance of the vegetation surface was reduced in lichen and feathermoss microsites compared to Sphagnum. Together, the shading effect and water-conserving physiology of the low light-adapted species in these peatlands suggests that shaded microsites effectively serve as water conserving zones for the moisture-dependent Sphagnum hummocks and hollows located in the adjacent and more open-canopy areas. The above impacts of trees on the surface energy and water fluxes likely offsets their transpiration water losses, potentially rendering them as net water conservation agents in the continental boreal plain.

3P30-0806.2 ID:3878 15:30

Groundwater recharge in a managed forest on the Oak Ridges Moraine, southern Ontario

Robert Bialkowski , *James Buttle*
Trent University
Contact: jbuttle@trentu.ca

The Oak Ridges Moraine (ORM) is a key hydrogeologic feature in south-central Ontario, and modeling-derived recharge estimates along the ORM have assumed constant values for major surficial geological deposits or land use types. However, substantial differences in water partitioning and storage within a given land cover could result in marked variability in groundwater recharge. The purpose of this study was to assess the influence of forest properties on groundwater recharge in the Ganaraska Forest, a mosaic of mixed hardwoods (MHW, > 80 years old) and red pine (RP) plantations of varying ages on the crest of the ORM. Water inputs and soil water storage (S) were measured in open sites and MHW and RP plantations (YRP - 20+ years old, ORP - 60+ years old) from June 23 – December 4, 2009. Potential evapotranspiration (PET) was derived using the Hamon model and recharge (R) below 1 m depth was calculated as the water balance residual. Total period precipitation was ~600mm and interception was similar for all forest sites (15 – 18% of total precipitation). Total PET was 365 mm and average total change in S ranged from 31 ± 15 mm (open) to 9 ± 11 mm (MHW). Total period R was greatest at open sites (235 ± 51 mm) compared to forest stands (179 ± 38, 169 ± 21 and 141 ± 56 mm for ORP, YRP and MHW sites, respectively), and was 39%, 29%, 28% and 23% of inputs for the respective sites. Open site R was significantly greater than that for forest stands whose R estimates were similar, consistent with their similar interception losses. Results suggest that reforestation may reduce recharge significantly within 20 years of planting, and that recharge during rainfall inputs may not change appreciably as red pine plantations gradually transition to MHW stands.

3P30-0806.3 ID:3907 15:30

Daily groundwater recharge derived from energy and water balance measurements on the Oak Ridges Moraine, southern Ontario

Andrew Farnsworth , *James Buttle*
Trent University
Contact: jbuttle@trentu.ca

Accurate estimates of groundwater recharge are required to model groundwater flow in key hydrogeologic features such as the Oak Ridges Moraine (ORM) in south-central Ontario. Such estimates are often simulated or based on monthly water balance calculations. The latter may miss the potential for short-term recharge events during periods when monthly potential evaporation exceeds precipitation. This study estimates daily groundwater recharge for a pasture on the crest of the ORM for the August 7 to October 21, 2010 period. Daily rainfall amount and intensity were measured, while evapotranspiration (ET) was estimated using the Bowen ratio energy balance (BREB) method. Regression of BREB ET data on potential ET estimates (Hamon model) were used to infill missing ET values. The vertical profile of soil water content (SWC) was measured at half-hourly intervals to 1 m depth. Recharge (R) below 1 m depth was calculated daily as the residual in the 1-d water balance. Period rainfall (P) was 282 mm, ET was 146 mm (52% of P), the change in SWC was 32 mm (11% of P) and R was 104 mm (37% of P). Annual R along the crest of the ORM is in the order of 360 mm (much of which would occur during Spring snowmelt), and the large late-Summer – Fall R observed here reflects wet conditions with rain on 67 of 119 days of measurement. This paper will examine the sensitivity of recharge estimates to alternative approaches to data infilling, as well as short-term SWC responses during recharge events. The potential control of joint P-SWC thresholds on the occurrence of significant recharge during the late-Summer – Fall period on the ORM will also be explored.

3P30-0806.4 ID:3938 15:30

Hydrological consequences of harvesting intensity in forested catchments: Discriminating a harvest signal under different climate scenarios

Samson Girma Mengistu [1], *Irena Creed* [1], *Frederick D. Beall* [2]
[1] University of Western Ontario
[2] Canadian Forest Service
Contact: sgirmame@uwo.ca

One of the challenges of field-based experimental manipulations is that the experiment occurs under a specific suite of climate conditions. We wanted to determine how the prevailing climate conditions and climate trends at the Turkey Lakes Watershed influenced the hydrological consequences of the harvesting experiment. The TLW has been experiencing a 1°C per decade rise in temperature and a 15 mm per decade decrease in average runoff over the past 30 years. The Regional Hydro-Ecologic Simulation Systems (RHESSys) model was applied to the experimental catchments of the Turkey Lakes Watershed to confirm our process-based understanding of what happened during the

experiment, and to explore the range of variability in hydrological consequences under different climate conditions representative of the region over the past 30 years and projected over the next 30 years. The model's hydrological parameters were calibrated for each of the harvested and reference catchments, and the validity of the calibrated models to simulate hydrologic reference conditions at the outlet of each catchment were checked using independent data sets. The simulations revealed that antecedent and post-disturbance climate conditions have a significant effect on the hydrological response and recovery of forested catchments to harvesting regimes.

POSTER General Biogeoscience / AFFICHE Séance générale sur la biogéoscience

Room / Endroit (Terrace / Terrasse), Chair / Président (Muhammad Altaf Arain), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-1001.1 ID:3906 15:30

Rain-induced production of N2O+N2 from wetlands accounts for a majority of the difference in dissolved nitrogen export among forested catchments

Eric Enanga [1], *Nora Casson* [2], *Irena Creed* [1]
[1] University of Western Ontario
[2] Trent University
Contact: eenanga@uwo.ca

We are unable to account for differences in dissolved nitrogen (N) export among catchments in the sugar maple forest of the Turkey Lakes Watershed (TLW). We hypothesized that nitrous oxide (N2O) and dinitrogen gas (N2) efflux accounts for this discrepancy. To test this hypothesis, N2O efflux was measured in plots using the static chamber method during the snow free season (May 1 to October 30) in 2006 to 2009 in one of the TLW catchments (C38). N2 cannot be measured directly, but was estimated by the ratio of N2: N2O (10: 1) established during rainfall simulation experiments where we measured N2O efflux in plots with and without acetylene (which inhibits conversion of N2O to N2). Minimal N2O+N2 efflux (<1 g N/ha/day) was observed on days without rain. However, on days with rain, N2O+N2 efflux was significant from wetland soils, with a linear increase of 0.019 g N/ha/day per millimeter of rain ($r2 = 0.71$, $p<0.001$). Process based monitoring of the wetland soil profile suggests that rain delivers water to the surface layers of the wetlands creating an oxygen poor environment where accumulated nitrate is first transformed to N2O and then to N2. In contrast,

N2O+N2 efflux from upland soils was not significant. We applied the relation of N2O+N2 efflux as a function of storm size to predict the N2O+N2 efflux over a 30-year record in catchments with varying proportions (0 to 25%) of wetland areas and found that the N2O+N2 efflux accounted for the majority of the difference in dissolved N export from the catchments. We conclude that rain can lead to substantial production of N2O+N2 from forest soils and that failure to account for gaseous N export may lead to an underestimation of N loss from forested catchments.

3P30-1001.2 ID:3588 15:30

Selective harvesting in Haliburton Forest and Wildlife Reserve Ltd., Ontario Canada: a sustainable practice?

Tyler Phillips [1], *Shaun Watmough* [2]
[1] Environmental and Life Science Graduate program, Trent University
[2] Environmental and Resource studies, Trent University
Contact: tylerphillips@trentu.ca

Forest harvesting has the potential to remove a large amount of nutrients from an ecosystem. This is particularly important in areas where soil nutrients are in short supply such as those found in south-central Ontario overlying the Precambrian Shield. In this study, the long-term sustainability of selective harvesting at Haliburton Forest, ON was assessed using a mass balance and forest chronosequence approach. Nutrient (Ca, Mg, Na, K, Mn, Fe, Al, C, N, S, P) losses from soil, biomass and coarse woody debris were measured over the course of the harvesting rotation. Plots were sampled in areas one year prior to being cut; immediately following harvest, three, five and ten years post harvest. Inputs of nutrients were obtained from bulk deposition measurements and weathering estimates using the PROFILE model. Nutrient losses from soil were estimated using current stream chemistry. Nutrient losses due to harvesting and leaching were compared to inputs in deposition and weathering to identify which nutrients are most likely to become limiting to forest productivity in a region that has been historically logged and has been heavily impacted by acid rain.

3P30-1001.3 ID:4009 15:30

The impacts of mosaic and aggregate representation of vegetation in land surface schemes on energy and carbon balances

Rong Li , *Vivek Arora*
Canadian Centre for Climate Modelling and Analysis
Contact: Rong.Li@ec.gc.ca

Current generation earth system models simulate dynamic aspects of the terrestrial biosphere by coupling physical land surface and biogeochemical terrestrial ecosystem modules. In most models, the physical land surface scheme treats vegetation as a homogeneous unit where different vegetation types present in a grid cell are lumped in some fashion for energy and water balance

calculations. However, terrestrial vegetation consists of natural or managed mosaic-like landscapes of discrete vegetation types. To represent this aspect more realistically we take advantage of the mosaic capabilities of the Canadian Land Surface Scheme version 3.4 (CLASS 3.4) and investigate the effect of aggregating vegetation attributes using coupled CLASS 3.4 and CTEM (the Canadian Terrestrial Ecosystem Model) models.

Simulations are performed at selected locations for two cases. In the first simulation, dynamically simulated vegetation attributes from CTEM are aggregated for different vegetation types and used by CLASS (i.e. the aggregate case) and all vegetation types present in a grid cell “see” the resulting common “aggregated” physical environmental conditions. In the second simulation, CTEM simulated vegetation attributes for a vegetation type are used for energy and water balance calculations for the mosaic tile of this vegetation type (i.e. the mosaic case) and each vegetation type present in a grid cell “sees” different physical environmental conditions. The results indicate that while the consideration of this “mosaic-ness” does affect energy and water balances, the differences in grid averaged quantities are not considerable. However, the simulated carbon balance can vary considerably between the two simulations. The amount of equilibrium vegetation biomass and soil carbon depends strongly on whether vegetation attributes are aggregated for use in grid averaged common energy and water balance calculations or whether energy and water balance calculations are separately done for each vegetation type.

3P30-1001.4 ID:3463 15:30

Terrain morphology and stand age influences on the rate of above ground biomass growth within a jack pine boreal forest landscape

Chris Hopkinson [1], *Laura Chasmer* [2], *Natascha Kljun* [3], *Heather Morrison* [4]
[1] Applied Geomatics Research Group
[2] Wifrid Laurier University
[3] University of Swansea, UK
[4] Centre of Geographic Sciences
Contact: chris.hopkinson@nscc.ca

Terrain morphology attributes of slope, aspect, and localised slope curvature can directly influence the availability of energy, moisture and nutrients at a point within the landscape. Consequently, localised terrain attributes have the ability to influence growing conditions either through processes of enhancing resource availability or limiting it. An obvious example is the tendency for some forest canopies to be taller in depression areas due to either increased moisture availability or increased competition for above canopy light energy. In this study, two comparable LiDAR datasets were collected three years apart over a boreal jack pine forest containing stands of varying age classes. Canopy height and fractional cover models were directly mapped from the LiDAR point clouds. Field data and digital hemispheric photography were collected coincident with both airborne acquisitions at several plots within four separate stand age classes ranging from approximately 90 years, 30 years, 11 years to 3 years old at the time of the first LiDAR data collection. The field data were used to model plot-level biomass using published allometric tables and these plot-level estimates of biomass were used to train a LiDAR model of biomass from the height and canopy cover data for both time periods. The two earlier LiDAR height and biomass models were then subtracted from the latter to quantify the spatial variability in the rate of growth. Preliminary results demonstrate that terrain attributes (particularly depressions) do influence the spatial variability in biomass and that the rate of growth variability with terrain varies with age class.

3P30-1001.5 ID:3486 15:30

Seasonal dynamics of vegetation communities of a previously harvested minerotrophic peatland: Using visual obstruction methods to estimate biomass and leaf area index

Maria Strack , *Priyanka Srivastava*
Department of Geography, University of Calgary
Contact: mstrack@ucalgary.ca

Peatlands in Canada are harvested for horticultural peat. Following abandonment active restoration methods are needed to return the site to a functional ecosystem. While methods for restoring *Sphagnum* dominated peatlands are well established, many disturbed minerotrophic peatlands exist where hydrochemistry may be inappropriate for *Sphagnum* establishment. In these cases spontaneous revegetation by vascular plants is greater than at ombrotrophic sites and these species may be beneficial to incorporate in restoration efforts. We investigated the seasonal development of six vegetation communities present at an abandoned minerotrophic peatland in Quebec and compared the results to fen communities in a neighbouring undisturbed fen. Biomass and leaf area index were estimated by harvesting, but also compared to visual obstruction of a calibrated ruler by the vegetation. While vascular biomass was higher at the abandoned site, bryophytes were rare. In contrast, bryophytes accounted for the majority of biomass in many undisturbed plots. Visual obstruction methods were well correlated with biomass and leaf area in individual vegetation communities. The utility of these methods to provide a rapid estimation of vegetation parameters frequently used in ecological and biogeochemical models will be discussed.

3P30-1001.6 ID:3317 15:30

Terrestrial-aquatic carbon cycling in Lake Simcoe: how much can a process-based biogeochemical model explain?

Stephen Oni [1], *Martyn Futter* [2], *Peter Dillon* [3]
[1] Environmental and Life Science Graduate program, Trent University
[2] Depratmet of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences
[3] Environmental and Resource studies, Trent University

Contact: stephenoni@trentu.ca

Landscape elements, watershed hydrology and climate-related processes interact in complex ways to regulate carbon dynamics and flow between terrestrial and aquatic systems. Past research has recognized the complexities of in-soil carbon processes in different soil horizons and in the open water-sediment and atmospheric interface. However, gaps still exist in integrating all these mechanisms so that we can simulate carbon dynamics in watersheds as environment changes. Here we present a modelling approach that integrates these processes at both temporal and spatial scales. The Integrated catchment model for carbon INCA-C links the effect of different landscape elements, soil biogeochemistry and aquatic processes with hydrologic flow paths to simulate watershed-wide carbon dynamics. We also explore how the approach can be used to further understanding of the potential impact of both climate-induced and land use changes on water quality of the tributaries draining into Lakes Simcoe. Our goal is to help watershed managers in designing effective mitigation strategies against the uncertain and changing future. Other possible carbon processes that are yet to be incorporated in this model are further discussed.

3P30-1001.7 ID:4052 15:30

Trace carbonyl compounds in North Atlantic waters- a survey using solid-phase microextraction (SPME).

Edward Hudson [1], *Parisa Ariya* [2]
[1] Department of Chemistry, McGill University
[2] Departments of Chemistry and of Atmospheric and Oceanic Sciences, McGill University
Contact: edward.hudson@mail.mcgill.ca

Volatile carbonyl compounds (aldehydes and ketones) in seawater are of interest because they can be both a product of and a substrate for biology, because they represent a sink for a portion of marine dissolved organic matter (DOM), and because, after transfer across the sea-air interface, they may affect oxidative processes in the troposphere. It is not known whether the oceans represent a net source or sink, with respect to the atmosphere, for these compounds, limiting our understanding of how they affect tropospheric oxidation chemistry. Our understanding of their role in these environmental compartments would be facilitated by methods allowing their routine determination in seawater. We have developed and applied a facile, low-cost, environmentally friendly solid phase microextraction method which permits the characterization of C1 - C9 carbonyl compounds in seawater, with low nanomolar or sub-nanomolar detection limits. We report carbonyl concentrations from surface and sub-surface seawaters of the Labrador Sea, which has a unique multi-layered thermal structure and thus the potential to distinguish the contributions of biology and of atmospheric exchange to volatile carbonyl biogeochemistry, and from surface waters of the Scotian Slope.

3P30-1001.8 ID:3487 15:30

Quantifying fugitive methane emissions from biodigesters

Ray Desjardins [1], *Tom Flesch* [2], *Devon Worth* [1], *Zhiling Gao* [3], *Xiaomei Li* [4]
(Presented by *R. Desjardins*)
[1] Agriculture and Agri-Food Canada
[2] University of Alberta
[3] Agricultural University of Hebei
[4] Highmark Renewables
Contact: desjardins@agr.gc.ca

Methane concentration in the atmosphere has been increasing as a result of industrialization. One of the main culprits is agriculture, which is responsible for approximately 40 to 50% of global methane emissions. Agricultural biodigesters, which have the potential to reduce greenhouse gas emissions while generating clean energy, also have the potential to be a source of methane if poorly maintained. Unaccounted methane emissions open the door to all kinds of abuses from inaccurate accounting to misleading demands for carbon credits. This talk will present the potential reduction in greenhouse gas emissions due to the biodigestion of livestock manure in Canada. We will also present a technique to quantify fugitive methane emissions from operational biodigesters using open-path lasers and an inverse modeling technique. Methane emissions estimates from sources around a modern Canadian biodigester will be presented for multiple periods of the year and 'hot spots' from which the majority of fugitive methane emissions originate will be identified. It will be shown that on average, fugitive emissions from the studied biodigester represented 3% of the total methane production, which is considerably lower than some rates being recommended for carbon offset calculations. It will also be shown that flaring efficiency was variable and considerably less than expected.

3P30-1001.9 ID:3943 15:30

Evaluation of soil acidy status in the Athabasca Oil Sands Region using ion exchange membranes

Ina Koseva , *Shaun Watmough*
Environmental and Resource Studies, Trent University, Peterborough, Ontario
Contact: iskoseva@trentu.ca

Recent critical load assessments have shown that acid-sensitive soils in the Athabasca Oil Sands Region (AOSR) might be at risk of acidification due to the high levels of sulphur and nitrogen emitted by industrial activities in the region. Base cation (sum of calcium, magnesium and potassium concentrations) to aluminum molar ratio (Bc/Al) in soil solution above 2.0 was used as a critical chemical criterion. The Bc/Al ratio in soil water has not been measured for upland soils in the region. In the present study, the performance of two commonly used methods for in situ measurement of soil solution chemistry, lysimeters and plant root simulator(PRS)-probes, was evaluated over the 2009 growing season at 3 micro-sites located 1 km away from an industrial point source in the AOSR. The

PRSTM-probes provide an estimate of root uptake of nutrients from the labile base cation pools and long-term buffering capacity of soils. Measurements of Bc/Al ratios at 25 cm soil depth at the micro-sites obtained using PRS(TM)-probes (median: 36.8) were high when compared with values from tension and zero-tension lysimeters (5.5–17.9). Ion exchange membranes installed vertically to the soil surface yielded a five-fold increase in Bc/Al ratios in soil solution when compared with measurements from horizontal PRS(TM)-probes. Overall, Bc/Al ratios remained above the critical limit of 2.0, with values increasing under conditions of low soil moisture and temperature, which suggests that soils at the study sites have not acidified.

POSTER Carbon Cycling of Canadian Forests and Peatlands / AFFICHE Cycle du carbone des forêts et tourbières canadiennes

Room / Endroit (Terrace / Terrasse), Chair / Président (J.H. McCaughey), Date (03/06/2010), Time / Heure (15:30 - 17:30)

3P30-1003.1 ID:4140 **15:30**

Environmental controls on carbon dioxide exchange in *Sphagnum* at Mer Bleue

Mandy Chong [1], *Tim Moore* [1], *Elyn Humphreys* [2]
[1] McGill University
[2] Carleton University
Contact: mandy.chong@mail.mcgill.ca

Vegetation composition in peatland ecosystems is being altered as a result of increases in N deposition, with increases in vascular plants and decreases in Sphagnum. An on-going N fertilization experiment at Mer Bleue, an ombrotrophic bog, located near Ottawa, Ontario was assessed for changes in microclimate. In addition, a controlled laboratory experiment was conducted to examine the impact of changes in light, moisture and temperature on moss photosynthesis. Increases in LAI in the highly fertilized plots resulted in significantly lower light levels, compared to the controls. Also, changes in shrub canopy affected the moisture and temperature patterns in the plots. Results in the lab showed that moss photosynthesis was affected by a combination of moisture, light and temperature. The attenuation of light through the vascular canopy is likely an important reason for the significant decrease in Sphagnum cover in the Mer

Bleue fertilization's highly fertilized treatments. The decline in moss abundance could have important implications on the overall C sink capacity of these ecosystems, causing these systems to switch from a sink to a source of C.

3P30-1003.2 ID:3856 15:30

Nitrogen limits the unlocking of carbon stores from peat deposits in swamps

Natalia Lecki , *Irena Creed*
University of Western Ontario
Contact: nlecki@uwo.ca

There has been an increase in the frequency and intensity of summer droughts on landscapes in the Great Lakes-St. Lawrence forest region. Water table depths within swamps are routinely dropping to 1 m below the surface, resulting in increased drying of the peat. We explored if these droughts are associated with increased peat decomposition and CO2 efflux to the atmosphere by simulation of drought conditions in a laboratory. We collected intact, 60cm-deep, saturated peat cores, partitioned them into intervals (0-5, 10, 15, 20, 30 to 60cm depth) and incubated them at 15° C. We determined the quantity and quality (ratio of C to N) of carbon pools in each peat increment, and as the peat dried down, we measured microbial biomass, extracellular enzyme activity (hydrolase enzymes that control the rate at which substrates are degraded and become available for biological uptake, and lignase enzymes that can minimize activity of hydrolase enzymes), and respiration when peat was saturated and as it dried out. The C pool was relatively constant in the peat profile, but the ratio of C to N showed a threshold change of < 25:1 above 30cm and > 25:1 below 30cm. Within the top 30cm, microbial biomass, extracellular enzyme activity, and respiration peaked at moderate moisture conditions and declined rapidly at relatively wet and dry conditions. In contrast, below 30cm, microbial biomass, extracellular enzyme activity, and respiration were extremely low at all moisture conditions. We conclude that only a portion of the carbon locked away in peat can be respired as CO2, and that N limits the unlocking of C from peat deposits at depth. Continued atmospheric N deposition combined with drought could play an important role in shifting swamps from sinks to sources of carbon to the atmosphere.

3P30-1003.3 ID:3735 15:30

Drought Influences on Soil CO_2 Effluxes in a Temperate Pine Forest

Emily Nicholas
McMaster University
Contact: nichole@mcmaster.ca

This study explores the main constraining environmental factors which affect soil CO_2 efflux during a spring and early summer experimental drought. The study site is a mature temperate (white pine) forest located at the Turkey Point Flux Station in Southern Ontario. Continuous soil CO_2 efflux measurements have

been collected since September 2008 using automated chambers in 20m x 20m reference and drought plots, where 90% throughfall was excluded from April 1st (JD 91) to July 3rd, 2009 (JD 184). Eddy covariance CO_2 fluxes and meteorological variables, including soil temperature and soil moisture at several depths, were also measured. Maximum half-hourly and monthly-mean soil CO_2 efflux values of 9.93 and 4.90 μmol CO_2 m^{-2} s^{-1}, respectively, were observed in the reference plot during September 2009. During the throughfall exclusion, soil CO_2 efflux from the drought plot decreased more rapidly as compared to reference plot, with a difference of 4.03 μmol CO_2 m^{-2} s^{-1}, which occurred on July 1st 2009 (JD 182). Comparison of both reference and drought soil CO_2 efflux with soil temperature at 5cm showed a positive logistic relationship (r^2= 0.76 and RMSE= 1.03 (reference) and r^2= 0.46 and RMSE= 1.26 (drought)). Analysis of residuals for soil moisture and soil CO_2 efflux relationship indicated that there is an increasing linear trend during soil moisture less than 0.09 and 0.12 m^3m^{-3} in the drought and reference plots, respectively. Soil moisture explains more of the variation in soil CO_2 efflux within the drought plot (r^2= 0.42). When soil moisture is above 0.09 and 0.12 m^3m^{-3}, the linear trend does not exist. A thorough understanding of the constraining environmental factors on soil CO_2 efflux is necessary to define how the efflux, along with its partitioned components, will be altered under future climate change, specifically during drought.

3P30-1003.4 ID:3515 **15:30**

Modelling Peatland Groundwater Residence Time Distributions and Implications for Peat Vulnerability

Paul Morris , *Mike Waddington*
McMaster Centre for Climate Change, McMaster University
Contact: pmorris@mcmaster.ca

Northern hemisphere peat soils contain approximately one third of all global soil carbon, and represent a highly significant sink for atmospheric carbon during the Holocene. The accumulation of deep peat deposits represents a sustained excess of net ecosystem productivity over decay losses on timescales of centuries to millennia. Recent evidence suggests that high porewater concentrations of dissolved inorganic carbon (DIC) compounds, the chemical end-products of decomposition, may lead to low energy environments in which decomposition becomes thermodynamically limited, providing a negative feedback to peat decay. Soil environments with rapid advective groundwater flow rates are likely to experience more rapid turnover of porewater, and therefore lower DIC concentrations, than slow-flowing, diffusion-dominated soils. Peatland porewater residence time distributions (RTDs) therefore may be powerful predictors of peat decomposition rates, and so peat vulnerability to climate change. We present results from a modelling study of RTDs in a conceptual peatland, and analyse the model's sensitivity to peat hydraulic properties. The model demonstrates high sensitivity to assumed rates of porewater solute diffusion, suggesting that future research should focus on establishing realistic

diffusion coefficients for DICs in deep peats. Different assumed depth profiles of peat hydraulic properties lead the model to predict markedly different behaviour in terms of percentage recovery of tracer after 1,000 simulated years. Predicted porewater turnover times also demonstrate continuous downcore variation, a finding which adds weight to the growing argument that peat profiles are not well represented by classification into the discrete layers of "acrotelm" and "catotelm". We conclude that, due to the limitations we demonstrate, the traditional diplotelmic model of peatland process and structure should be discarded in favour of continuous descriptions of the peat profile. Additionally, we identify the need for field estimates of groundwater residence time, to examine peatland vulnerability to human and climate-mediated disturbance.

ARGO TOWNHALL / DISCUSSION ARGO

Room / Endroit (Chaudière), Chair / Président (Howard J. Freeland), Date (03/06/2010), Time / Heure (18:00 - 19:00)

3E07.1 ID:4129 18:00

Argo Townhall on the long-term sustainability of Canadian Argo

Howard Freeland [1], *Denis Gilbert* [2]
[1] Institute of Ocean Sciences, Sidney, B.C., Canada, V8L 4A2
[2] Institut Maurice-Lamontagne, Mont-Joli, Québec, Canada, G5H 3Z4
Contact: howard.freeland@dfo-mpo.gc.ca

The implementation of the Argo (http://www.argo.ucsd.edu/) ocean observation system measuring temperature and salinity in the top 2000 m of the global ocean was praised at the OceanObs'09 meeting in Venice, Italy. Practical applications of Argo temperature and salinity data include improved ocean climate hindcasts, nowcasts and forecasts. In addition, it has become increasingly clear that Argo temperature and salinity data offer the potential of better forecast skill in seasonal to decadal climate predictions, a topic of great interest to Environment Canada. Until recently, the Department of Fisheries and Oceans Canada (DFO) had been the sole provider of Argo floats. However, this situation changed with the purchase of a substantial fraction of the Canadian Argo floats by the Canadian Ice Service of Environment Canada (EC) in the last two years. Moreover, the Department of National Defence (DND) and University scientists recently provided tangible support to Canadian Argo by paying part of the satellite telecommunication costs. While these signs of good will are encouraging, Canadian Argo remains fragile with no firm long-term financial commitments from DFO, EC, DND or universities. With the prospect of severe financial restraints

across federal departments in the next year(s), the risk of seeing Canadian Argo in jeopardy appears very real unless we can establish a mechanism or organizational structure that can stabilize its sources of funding and operations. We would like to propose the creation of a governing board of Canadian Argo with representatives from the federal departments of Fisheries and Oceans, Environment Canada, National Defence, and universities. Those representatives would be Canadian Argo's antennas and channels of communication with DFO, EC, DND, and NSERC. The aim of the meeting will be to discuss this proposal and, possibly, to identify individuals willing to serve on the governing board for initial mandates.

Plenary Day 4 / Plénière jour 4

Room / Endroit (Ballrooms ABC), Chair / Président (David Fissel and Spiros Pagiatakis), Date (04/06/2010), Time / Heure (08:30 - 10:00)

P4.1 ID:4177 INVITED/INVITÉ 08:30

Environmental Prediction, Seamless and Earth System Modeling: an outlook. Prévision environnementale et modélisation intégrée du système terre : un aperçu.

Michel Béland
Environment Canada
Contact: michel.beland@ec.gc.ca

Over the last few of decades, there has been tremendous scientific progress in the fields of atmospheric, oceanic, and more generally speaking earth system sciences and modeling. There were many drivers for this progress, chiefly amongst them our unending quest to better understand the different physical, chemical, and more recently biogeochemical and socioeconomic processes at play in earth's environment and societies, and how they actually shape its past and future states. Yet, at the same time, we have been noticing acceleration in global environmental change, much of it of anthropogenic origin, and unfortunately, much of it potentially of a hazardous nature for life as we have experienced it since the beginning of mankind. Mitigation and adaptation strategies are today intensely debated globally, and we believe environmental prediction, seamless and earth system modeling (including of course climate modeling) will be amongst the key providers of information for decision-making. The presentation will start with a short history of recent progress, and propose a definition of environmental prediction, and seamless and earth system modeling. It will examine some of the recent global data on key trends impacting on the future state of the environment, and then proceed with a description of the new set of modeling tools (and the infrastructure needed to support these) that we

believe will be needed to inform an efficient response to these environmental challenges. We will also provide some recent examples of Canadian initiatives in this field, in relation to other similar international activities.

Dans les dernières décennies, on a pu observer des progrès importants dans les sciences et la modélisation de l'atmosphère, de l'océan, et plus généralement parlant, du système terre. Plusieurs facteurs sont à l'origine de ce progrès, plus particulièrement notre quête insistante pour mieux comprendre les différents processus physiques, chimiques, et plus récemment bio-géo-chimiques et socio-économiques en jeu dans l'environnement terrestre, et qui ont façonné son passé et façonneront son futur. Simultanément, on observe une accélération du changement environnemental global, en grande partie d'origine anthropogénique, et malheureusement, en grande partie potentiellement dangereuse pour le biôme terrestre, tel que nous l'avons expérimenté depuis l'apparition de l'homme. On discute aujourd'hui intensément autour du globe de stratégies de mitigation et d'adaptation, et nous croyons fermement que la prévision environnementale, et la modélisation intégrée du système terre (incluant bien sûr la simulation du climat) formeront une source prédominante d'informations pour la prise de décision. La présentation débutera par un bref historique des progrès récents, et proposera une définition de la prévision environnementale, et de la modélisation intégrée du système terre. On discutera des données globales les plus récentes sur les principaux facteurs ayant un impact potentiel sur l'état futur de l'environnement terrestre, pour poursuivre ensuite par une description du nouvel outillage de modélisation (incluant son infrastructure nécessaire) qui, nous le croyons, sera requis pour correctement informer les réponses aux défis environnementaux. Nous terminerons en présentant quelques exemples récents d'initiatives canadiennes dans ce domaine, en les situant dans un contexte international.

P4.2 ID:3682 INVITED/INVITÉ 09:15

Hydrologic Impacts of a Shrinking Cryosphere

Laurence C. Smith
UCLA
Contact: lsmith@geog.ucla.edu

According to most climate model projections, the coming century will see substantial increases in mean air temperatures and winter precipitation around the northern circumpolar latitudes. These projections are generally consistent with a sparse collection of long-term field observations, including rising river baseflows, a shift to earlier spring discharge, warmer borehole temperatures in permafrost, disappearance of perched lakes over permafrost, and others. At the same time, considerable media attention has been focused on evidence of a shrinking cryosphere, ranging from diminished extent of alpine glaciers and late-summer Arctic sea ice, to speculations about carbon release from thawing permafrost soils, to remotely-sensed mass losses from the Greenland ice sheet.

Despite many obvious connections between them, scientific understanding of how a shrinking cryosphere will affect regional water and carbon cycles remains poor, especially at the landscape scale and over time periods of decades. Basic questions like "will the land surface become wetter or drier as it thaws?" and "will it sequester carbon or release it?" have yet to be answered with confidence. Such questions have strong policy as well as scientific implications, ranging from the economic viability of remote extraction industries to carbon emissions targets to wetland conservation. The ability of northern societies to react to these phenomena is shaped by evolving legal frameworks, like land-claims agreements in North America, and resource economics, like the oil & gas industry in West Siberia. This plenary talk will summarize some important achievements and outstanding gaps in our understanding of the hydrologic and carbon-cycle impacts of a shrinking cryosphere.

Coastal Oceanography and Inland Waters (Part 1) / Océanographie côtière et les eaux intérieures (Partie 1)

Room / Endroit (Ballroom A), Chair / Président (Jinyu Sheng), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B01.1 ID:3301 10:30

Modelling Spring Salinity Variations in the Broughton Archipelago

Michael Foreman[1], *Dario Stucchi*[1], *Ming Guo*[1], *Piotr Czajko*[2], *Joe Reimer*[2]
[1] Institute of Ocean Sciences, DFO
[2] Department of Mechanical Engineering, University of Victoria
Contact: mike.foreman@dfo-mpo.gc.ca

A circulation model for the Broughton Archipelago region of British Columbia is used to simulate the time-varying, three-dimensional velocity, temperature, and salinity fields that are required by a companion model for sea lice behaviour, development and transport. The simulation is carried out for May 2008, a time of year when lower near-surface salinities arising from high river discharges and warmer waters resulting from increased solar radiation and warmer air temperatures are expected to have more dramatic impacts on lice development and survival than in the early spring. We are particularly interested in determining if the model can reproduce observed, near-surface salinity variations of 17 psu over a few days.

4B01.2 ID:3794 10:45

An FVCOM-based circulation model off Newfoundland and Labrador

Guoqi Han [1], *Zhimin Ma* [2], *Brad De Young* [2], *Mike Foreman* [1]
[1] Fisheries and Oceans Canada
[2] Memorial University of Newfoundland
Contact: Guoqi.Han@dfo-mpo.gc.ca

We present a three-dimensional, prognostic and nonlinear circulation model, the finite volume coastal ocean model (FVCOM), in the Newfoundland offshore. The FVCOM uses unstructured grid in the horizontal and thus allows efficient and effective use of the grid resolution to resolve coastal and shelf-scale features. The model results are evaluated against in situ current measurements and tide-gauge observations, and compared with those from an earlier finite element model using the same horizontal grid mesh. The FVCOM results show approximate agreement with observations and improvement over the solutions from the finite element model.

4B01.3 ID:3495 11:00

A FE regional ocean model applied to the coastal ocean of British Columbia.

Roy Walters
O-RM
Contact: rawalters@shaw.ca

The coastal ocean is characterised by highly irregular shorelines and topography and hence provides a natural setting for the application of unstructured grid methods. An objective of the present work is to develop a robust, accurate, and efficient numerical model that can be used for large-scale high-resolution simulations of coastal and regional ocean dynamics. The model RiCOM (River and Coastal Ocean Model) is a multipurpose 3D primitive equation hydrodynamic model that uses a semi-implicit time approximation and uses a finite element (FE) spatial discretization that is based on the RT0 triangular and quadrilateral elements. This approach belongs to a class of methods where the continuity equation reduces to a finite volume (FV) formulation (conserves mass both locally and globally). A consistent FV scalar transport model provides sediment transport and solute submodels. The model has been applied to a wide range of problems including tides, residual and baroclinic circulation, tidal power generation, and tsunami generation, propagation and runup. Time permitting, the results are presented for two problems: 1. Recent work examining the hydrodynamics of the the inland waters of coastal British Columbia, Canada, where simulations reproduce the observed tides and currents as well as known eddy structures. 2. Simulation of a tsunami generated by a Cascadia subduction event with high resolution around Ucluelet. Some of the high velocity and high Froude number flows are similar to tidal rapids.

4B01.4 ID:3562 11:15

Simulating Three-Dimensional Circulation and Hydrography in Halifax

Harbour Using a Nested-Grid Ocean Circulation Model

Shiliang Shan , *Jinyu Sheng*
Dalhousie University
Contact: sshan@phys.ocean.dal.ca

Halifax Harbour is a multi-use estuary with great environmental and economic values. Raw sewage and wastewater had been dumped directly into Halifax Harbour for centuries, leading to poor water quality of this critical coastal system. A three-dimensional nested-grid coastal ocean circulation model, known as NCOPS-HFX (Nested-grid Coastal Ocean Prediction System for Halifax Harbour), has recently been developed for simulating circulation and hydrography and associated spatio-temporal variability in Halifax Harbour. The NCOPS-HFX is driven by tides, meteorological forcing and buoyancy forcing associated with freshwater discharges. We assess the model performance by comparing model results with observations including tide gauges and monthly mean climatology of temperature and salinity, which was newly constructed from historical hydrographic observations in the harbour. Model results demonstrate that currents in the harbour are significantly affected by tides and wind forcing with an intense tidal jet in the Narrows and a weak salinity front in the Bedford Basin. The time-mean circulation produced by the model is characterized by a typical two-layer estuarine circulation.

4B01.5 ID:3524 11:30

Neural Network Analysis of Biological and Physical processes off the Newfoundland Coast

Joe Craig
dfo
Contact: joe.craig@dfo-mpo.gc.ca

The Atlantic Zone Monitoring Programme was initiated by DFO a decade ago with the aim to describe and understand marine processes at the lower trophic levels in the context of physical processes. While significant progress has been made in acquiring data, efforts to link the biology and physics have been challenging for a variety of reasons, among which are the high variability of many of the time series, operational challenges in maintaining a satisfactory sampling regime and finding mechanistic models which can be used to integrate the available data. This has motivated the use of the nonlinear and multivariate capacities of neural networks as an empirical approach to identify inter-relationships between the time series of data and derived variables. Preliminary results will be presented and discussed with respect to the AZMP data in the Newfoundland region

4B01.6 ID:3378 11:45

A study of the circulation of eastern Canadian seas using CECOM: model results and model validation

Yongsheng Wu , *Charles Tang* , *Charles Hannah*
Bedford Institute of Oceanography
Contact: wuy@mar.dfo-mpo.gc.ca

The circulation on the continental shelves along the eastern Canadian coast plays an important role in the water transport from the Arctic to subtropical Atlantic. The water flows from Baffin Bay passing Labrador Shelf, N.E. Newfoundland Shelf and the Grand Banks to the Gulf of St. Lawrence and the Scotian Shelf. Most previous modelling studies focus only on one or two of above regions thus compromise the integrity of the circulation. In this study, we present a high resolution 3-D coupled ice-ocean circulation model. The domain of the model extends from northern Baffin Bay to the north wall of the Gulf Stream, and from the St. Lawrence Estuary to 42°W. The model is implemented on a rotated spherical coordinate system with a resolution of 0.1°×0.1° and 21 vertical levels. The model is forced with 3-hourly atmospheric fluxes covering a period of 11 years. The model results are compared to observed transports and surface drifter current data. The comparisons show that the model results are in reasonably good agreement with the observations. The main features of the circulation are a cyclonic gyre in the Labrador Sea, the strong Labrador Current over the shelf break, and recirculation of the Labrador Current water to the central Labrador Sea. The circulation on the western and northern continental shelves is dominated by southward flows, and the recirculation mainly occurs in the deep water of the Labrador Sea. The recirculation in spring and summer is stronger than that in winter and fall. This seasonal variation, however, is opposite to the seasonal variations of the currents over the shelf where the currents in winter and fall are stronger than those in spring and summer.

Ensemble forecasting: current and emerging applications (Part 1) / Prévisions d'ensemble : applications actuelles et émergentes (Partie 1)

Room / Endroit (Ballroom B), Chair / Président (Bertrand A. Denis), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B02.1 ID:3737 **10:30**

On the use of ensembles to understand what went wrong in the forecast of the December 9-10 2008 storm

Normand Gagnon [1], *Bertrand Denis* [1], *Ayrton Zadra* [2]

[1] Centre météorologique canadien / développement, Service météorologique canadien
[2] Recherche en Prévision Numérique / A, Service météorologique canadien
Contact: Normand.Gagnon@ec.gc.ca

On December 9-10 2008, a “Colorado-low” storm has impacted Eastern Ontario and Southwestern Quebec leaving more snow than expected causing major traffic problems in the Montreal metropolitan area for two days. The forecasts done using the CMC suite of models were not very good particularly for the position of the low on December 10 even at 48 hour lead time. The performance of MSC global ensemble system was globally poor as well except for one member (no. 17) out of the ensemble of 20. The MSC ensemble is based on a multi-model approach were different flavors of the GEM model are used differing in the choice of the physical parameterizations used. On that case, no clear correspondence between forecast error and the use of a specific convective scheme or surface scheme was found. A reforecast was done in initializing every member using the analysis of member 17. The effect was major and all forecasts were corrected. Therefore the bad performance of the original forecasts were due to an inappropriate initialization. In parallel to this ensemble-oriented investigation, a singular vector analysis has revealed a similar sensitivity of the forecast to the initial conditions for that specific case.

4B02.2 ID:4509 10:45

Verification of GEM-REG and REPS Forecast Precipitation Amounts During Significant Events

Rares Gheti , *Ivan Dubé*
SMC, CPIQ
Contact: louise.bussieres@ec.gc.ca

A Regional Ensemble Prediction System (REPS) set up by Environnement Canada is compared with the regional Global Environmental Multiscale model (GEM-REG), which is the operational model used in MSC’s forecast centres. The goal of this study is to evaluate the performance of both GEM-REG and REPS when significant precipitation amounts are forecast and/or observed in order to determine the relevance of including the regional ensemble output in the forecast process. Nine sites within Quebec region have been considered for a time span covering six months over the past winter (November 2009 to April 2010). Preliminary results show that precipitation amounts are often over-estimated by both numerical model systems, with the REPS having a significantly smaller bias and root mean squared error (RMSE) when compared to the GEM-REG. The GEM-REG catches more significant events while the REPS has a lower false alarm rate. More research is actually under way in order to determine the extent to which local effects (e.g. onshore flow or orographic lift) play an important role in QPF over-estimation and if/how the REPS can be used to offset that. More data is needed and will be gathered over the next few months in order to improve our understanding.

4B02.3 ID:3323 11:00

A probabilistic wind speed forecast product blending hurricane centre-based fields with the CMC dynamical ensemble

Chris Fogarty [1], *Peter Bowyer* [2], *Rick Knabb* [3]
[1] National Lab for Marine and Coastal Meteorology / Canadian Hurricane Centre
[2] Canadian Hurricane Centre
[3] Central Pacific Hurricane Center
Contact: chris.fogarty@ec.gc.ca

It is often difficult to discriminate the wind circulation associated with a tropical cyclone (TC) from the large-scale synoptic environment which can include strong zones of high pressure, or large low pressure systems resulting from extratropical transition. Gale-force winds can often exist well beyond the actual TC circulation, which may not be depicted well by the traditional TC-only wind products issued by the National Hurricane Center (NHC) in Miami. An augmented product is being explored at the National Lab for Marine and Coastal Meteorology that involves the merging of NHC's TC probabilistic wind "swath" fields with fields cast in a similar manner from the CMC dynamical model ensemble covering the large-scale environment. Such a product could be particularly useful for interests in the marine community making medium-range decisions that are dependent on wind and waves - regardless of the weather system generating them. Some examples will be shown highlighting the added value of fields generated during extratropical transition of select events in recent years.

4B02.4 ID:3887 11:15

Current state of the Canadian wave ensemble forecast system

Syd Peel , *Roop Lalbeharry*
Meteorological Research Division/Environment Canada
Contact: syd.peel@ec.gc.ca

A Canadian wave ensemble forecast system has been developed, using 10-m winds from the Canadian atmospheric ensemble to drive the WAM 4.5 wave model. From the resulting ensembles of wave properties such as significant wave height and peak period are constructed probabilities of events pertinent to marine interests. Hence, the probability that the significant wave height will exceed 5 metres can be obtained as that proportion of the members of the wave ensemble forecasting wave heights greater than 5 metres. This raw empirical probabilistic forecast suffers from a certain granularity due to the finite sample of ensemble members. More realistic probabilistic models have been sought by fitting kernel density estimators (KDEs) to the ensemble samples. These KDE models can eke out modest improvements in skill over the raw empirical forecasts of exceedance probabilities for certain thresholds of the significant wave height. In the case of peak period, on the other hand, for which probabilities are generated for the predictand to fall within certain intervals (e.g. the probability that the peak period lies between 5.5 and 6.5 s), the KDE forecasts show marked improvement in skill

over the raw empirical forecasts. Results from the verification of probabilistic forecasts of the Canadian wave ensemble will be presented to illustrate the above points. Application of multivariate KDE models to the computation of joint probabilities of predictands such as wind speed and direction will also be discussed. Finally, planned improvements to the current configuration of the wave ensemble system will be outlined.

4B02.5 ID:3908 **11:30**

Predicting Fire Weather Using Ensemble Forecasts

Kerry Anderson , *Rod Suddaby* , *Steve Taylor*
Canadian Forest Service
Contact: kanderso@nrcan.gc.ca

This presentation describes a methodology to predict the fire weather severity for the next 15 days using the North American Ensemble Forecasting System (NAEFS). The Canadian Forest Fire Weather Index (FWI) System is a model developed by the Canadian Forest Service (CFS), which has been used operationally across the country since 1969. This system uses the local noon measurements of temperature, relative humidity, wind speed and 24-hour rainfall to predict fire weather conditions and potential fire behaviour. These variables are currently being predicted using the NAEFS. Using these forecasts, the CFS is now producing medium-range fire weather forecasts, which are being presented through the Canadian Wildland Fire Information System (CWFIS) website.

4B02.6 ID:3897 **11:45**

The THORPEX Interactive Grand Global Ensemble (TIGGE) - A worldwide collaborative ensemble forecasting project

Laurence Wilson
(Presented by *Lawrence Wilson*)
Meteorological Research Division
Contact: lawrence.wilson@ec.gc.ca

The "model of the day" concept, often used by forecasters in their daily assessments of weather situations, is based on the assumption that the best of a set of reasonably accurate NWP models can be chosen each day, and that the "best" model may change from day to day, according to the situation. By extension, the combination of several models from different sources into an ensemble might be expected to better capture the uncertainty in the forecast all the time. The TIGGE project is an extension of this idea to ensembles, whereby ensemble forecasts from 10 centers which run global ensembles are archived in three locations in near real time, for use in multimodel ensemble experiments. The central question to be answered is whether a "super" ensemble made up of several of these individual ensembles can produce better probability forecasts than the best individual ensemble. If so, then an operational "global interactive forecast system" (GIFS) can be successfully launched.

Canada is a full participant in TIGGE; the archive now contains 2 years of our ensemble output. This presentation will include a description of the research opportunities provided by TIGGE and summarize the research results to date.

Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 2) / Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 2)

Room / Endroit (Ballroom C), Chair / Président (John Pomeroy), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B03.1 ID:4007 **10:30**

Inter-comparison of energy available for snow melt among regenerating forest stands in watersheds frequented by rain-on-snow

William Floyd [1], *Markus Weiler* [2], *Younes Alila* [3], *Robert Hudson* [3]
[1] BC Ministry of Forests and Range and University of British Columbia
[2] University of Freiburg
[3] University of British Columbia
Contact: william.floyd@gov.bc.ca

Forest harvesting has been linked to increases in peak stream flow and landslide rates in watersheds frequented by rain-on-snow (ROS) processes. In British Columbia, ROS stand-level hydrologic recovery research has focused on gross differences in winter snow water equivalent (SWE) and rain interception in spring, summer and fall among regenerating forests. Research in Oregon and Washington has examined energy balance differences among newly harvested sites and mature forest stands. There is limited analysis of energy available for snowmelt in regenerating forests during ROS. We installed 24 research plots within two elevation bands distributed among newly harvested, regenerating and old growth forest stands in Russell Creek Experimental Watershed on Northern Vancouver Island. A snow course was completed at each plot every two to three

weeks. All plots contained a snowmelt lysimeter and a data logger collecting air temperature and relative humidity. Eight of the 24 plots measured soil and snow temperature and used time-lapse photography to determine changes in snow depth. Plots were located within a network of meteorological stations collecting total precipitation, windspeed, air temperature, relative humidity and incoming solar radiation. Using a selection of ROS events from 2005-2007, the Cold Regions Hydrological Model (CRHM) will be used to calculate the energy balance at each plot to model snowmelt. Modelled outputs will be compared to lysimeter output, snow depth and snow course observations to validate energy calculations. Stand level energy balance recovery will be discussed in the context of improving current methods used to assess stand level hydrological recovery in ROS environments. This will serve as a first step towards using CRHM to investigate the relation between stand level and watershed scale recovery in coastal watersheds.

4B03.2 ID:4058 10:45

Compositional Change of Meltwater Infiltrating Frozen Ground

Gro Lilbaek [1], *John Pomeroy* [2]
[1] Department of Renewable Resources, University of Alberta, Edmonton, AB, Canada
[2] Centre for Hydrology, Department of Geography and Planning, University of Saskatchewan, Saskatoon, S
Contact: gro.lilbaek@ualberta.ca

Meltwater reaching the base of the snowpack may infiltrate the underlying stratum, form runoff, or refreeze, forming a basal ice layer. Frozen ground underneath a melting snowpack constrains infiltration, promoting runoff and refreezing. Compositional changes in chemistry take place for each of these flowpaths as a result of phase change, contact between meltwater and soil, and mixing between meltwater and soil water. Meltwater ion concentrations and infiltration rate into frozen soils both decline rapidly as snowmelt progresses. Their temporal association is highly non-linear and both theoretical and experimental assessments of the impact of enhanced infiltration have shown that this association causes a greater ion load to infiltrate leading to relative dilute runoff water. Sensitivity analysis showed that the magnitude of this ‘enhanced infiltration’ is governed by initial snow water equivalent, average melt rate, and meltwater ion concentration factor. Based on alterations in water chemistry due to various effects, including enhanced infiltration, three major flowpaths were hypothesized distinguishable: overland flow, organic interflow, and mineral interflow. Laboratory experiments were carried out in a temperature-controlled environment to identify compositional changes in water from these flowpaths. Samples of meltwater, runoff, and interflow were filtered and analyzed for major anions and cations. Chemical signatures for each flowpath were determined by normalizing runoff and interflow concentrations to meltwater concentrations. Results showed that changes in ion concentrations were most significant for H^+, NO_3^-, NH_4^+, Mg^{2+}, and Ca^{2+}. Repeated flushes of meltwater caused a washout of ions from the flowpaths. In the field, samples of soil water and ponding water were collected daily from a Rocky Mountain hillslope during snowmelt. Their normalized chemical compositions were compared to the laboratory-identified signatures to evaluate the flowpath. The majority of the flowpaths sampled had chemical signatures indicating mineral interflow, only 10% showed unmixed organic interflow; no samples indicated overland flow.

4B03.3 ID:3485 11:00

Correcting the effects of meltwater percolation on ice core thermometry

Tara Moran
University of Calgary
Contact: tamoran@ucalgary.ca

Records of stable water isotope ratios (δ18O, δ2H) in ice cores from both the Greenland and Antarctic ice sheets have been used as high-resolution proxies for past air temperatures. However, there is potential for the isotopic information contained in solid precipitation to be modified after deposition by various processes including, wind scour, erosive and depositional sublimation, vapour diffusion, and, of interest to this research, meltwater percolation and refreezing. Field-based investigations of meltwater percolation in an Arctic snowpack show enrichment of isotopic ratios during periods of summertime melt. This finding has important implications for the paleoclimatic community because isotopic enrichment ultimately results in the overestimation of air temperatures derived from melt-affected ice cores. We present a means of correcting temperature overestimations by applying a correction term to the isotopic ratios, calculated from the amount of melt observed in an ice core record. While this research provides a valuable first step toward improving the accuracy of temperature reconstructions, the factors that drive isotopic modification are complex, and more data and research are required to better isolate the processes responsible for isotopic modification within Arctic snowpacks.

4B03.4 ID:4064 11:15

Topographic control on the depth of thaw in a peat covered continuous permafrost site in the arctic tundra and implication on the runoff production.

Stefano Endrizzi [1], *Philip Marsh* [1], *William Quinton* [2]
[1] National Hydrology Research Centre, Environment Canada, Saskatoon, Canada
[2] Cold Regions Research Centre, Wilfrid Laurier University, Waterloo, Ontario, Canada
Contact: stefano.end@gmail.com

In permafrost dominated, tundra environments a spatially variable thaw depth, when combined with spatially variable water supply, organic soil thickness, and depth variable hydraulic conductivity in organic soils, has a significant impact on the flow of water from uplands to the stream channel, and therefore on stream discharge. The purpose of this work is studying how topography controls the depth of thaw. The study is performed using the hydrologic model GEOtop, which

was applied to the Siksik Creek drainage basin located in proximity of the Mackenzie delta, and characterized by a relatively gentle topography (elevation from 0 and 80 m a.s.l. and area of 1 km2). GEOtop is a grid-based model that uses high resolution topographic data from Lidar, for example, and includes a complete surface energy balance scheme that accounts for variations in the turbulent and radiant fluxes. The model also has a complete subsurface heat and water flux scheme that is able to route water and energy both vertically and laterally. Topography affects the spatial variability of the depth of thaw through its control exerted on the surface energy balance and subsurface flow. The latter directly affects soil moisture, and then the thermal conductivity of the peat soil. The results show that the major effect is played by subsurface flow, and the surface energy balance spatial variability has very little effect. In order to understand the processes in environments with more rugged topography, virtual topographies with more accentuated slopes and elevations have been derived from the topography of the Siksik basin. It is shown that as the topography becomes more and more rugged, the controlling effect of the surface energy balance becomes more and more important, but the subsurface flow still remains significant and strongly affects the spatial variability of the depth of thaw.

4B03.5 ID:3460 11:30

Water resources implications of an actively growing, subsiding and slumping ice-cored moraine; 1949 to 2007

Chris Hopkinson [1], *Michael Demuth* [2]
[1] Applied Geomatics Research Group
[2] Geological Survey of Canada
Contact: chris.hopkinson@nscc.ca

As glacier extents in the Canadian Rockies diminish, the proportional contribution of groundwater and other baseflow inputs to headwater river runoff is gradually increasing. While glacial wastage volumes and the implications to downstream runoff have been the focus of many studies, the contribution from lateral moraine ice-core melt has received little attention. Studies of long term geodetic datasets collected over the Peyto Glacier and surrounding environs suggest that commensurate with decreasing exposed ice extents there is a volumetric increase in the reservoir of debris covered ice cored moraines surrounding glacier margins. Field observations support the hypothesis that these storages of buried ice are increasing during the current period of glacier recession but the relative proportions of buried ice melt vs. exposed ice melt in the Rockies, and the impact this might have on future water resources, are unknown. The talk will present the results of multi-temporal geodetic observations over a lateral moraine (1949, 1966, 1993, 2000, 2002, 2006, 2007) to quantify rates of spatial expansion, vertical subsidence and motion. Downwasting over the lateral moraine surface averaged 1.5 m p.a. While some of the downwasting can be attributed to slope creep, slumping and general mass wasting processes, the lack of debris volumes at the foot of slope clearly indicate that some other process dominates. By comparing the ratios of moraine to exposed ice

downwasting, we find that commensurate with increases in area through time, the rate of moraine volumetric loss is also increasing. During the last 7 years of the record, up to 5% of the total volumetric loss (exposed ice and moraine) from the Peyto basin was from ice-cored moraine areas. We hypothesize that most of this volume is lost from the basin in the form of melt water from inside ice-cored moraines.

4B03.6 ID:3415 **11:45**

Evaluation of the heat-pulse probe method for determining frozen soil moisture content

Yinsuo Zhang , *Mike Treberg* , *Sean Carey* , *Elyn Humphreys*
Department of Geography and Environmental Studies, Carleton University
Contact: yinsuo_zhang@carleton.ca

Heat-pulse probes (HPP) have been utilized to determine soil thermal properties and water content in unfrozen soils. However their applications in frozen soils are complicated due to phase change and unfrozen water. The objectives of this study are to (i) establish the optimum heat applications (duration and intensity) to limit melting, (ii) find appropriate mathematical solutions to determine the soil moisture content (ice and water), and (iii) evaluate the applicability for frozen mineral and organic soils. A custom built HPP was tested at moisture levels that varied from saturation to oven-dry and soil temperatures from 0 to -11 °C. The applied heat pulse durations varied from 8 to 60 seconds, with heat application of 50 to 2000 J m-1. Four mathematical solutions were compared. Three are analytical methods: Instantaneous Infinite Line Source (IILS), Pulsed Infinite Line Source (PILS) and Pulsed Finite Line Source (PFLS), and the fourth a one-dimensional Finite Difference Numerical Method (FDNM) in radial coordinates. While all analytical methods assumed no phase change, the numerical model considered ice melt and unfrozen water. Preliminary conclusions are: (i) the standard 8-second heating pulse worked well when soil temperature were < -10 °C; (ii) with constant heat inputs, temperature changes varied with soil texture and moisture content, suggesting it is more desirable to maintain a pre-defined temperature change by varying the heating time to limit ice melt; (iii) FDNM gave the best performance for all tests, improving simulation results when minor melting occurred during heating. (iv) IILS was computationally straightforward, but may only be appropriate for 8-second heat pulse applications; and (v) PILS and PFLS had almost identical results and worked reasonably well when no melting occurred during heating. The above conclusions help provide guidelines for the proper utilization of heat pulse techniques for frozen soil water measurements.

IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 1) / AIP et les études reliées à l’atmosphère, l’océanographie et l’hydrologie (Partie 1)

Room / Endroit (Richelieu), Chair / Président (John Gyakum and Fumin Xu), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B04.1 ID:4027 **10:30**

Trends in Canadian Surface Temperature Variability in the Context of Climate Change

John Gyakum , *Jessica Turner*
McGill University
Contact: john.gyakum@mcgill.ca

Much of the previous work on trends in temperature extremes has considered anomalies relative to a fixed base period climatology. Calculated in this way, trends toward more extreme warm events and less extreme cold events will be found if the mean temperature is warming. In this study we calculate anomalies relative to a 30-year running mean in order to examine trends in surface temperature variability and extremes separately from changes in the mean. The difference between trends calculated relative to a running-mean and those calculated relative to a stationary mean will depend on the magnitude of the trend in the mean. Monthly trends in the positive, negative and absolute value of daily minimum and maximum temperature anomalies at 158 stations across Canada are presented. The slopes of the trends and their significance are calculated using non-parametric methods. Trends are strongest in winter and early spring. Decreasing variability is found in the west and northeast with the greater part of this reduction due to less intense cold anomalies. Regions of increased variability exist in the prairies during winter and the Atlantic Provinces in early spring. In general the trends in variability are small compared to the mean temperature trends, implying that while the mean of the temperature distribution at Canadian sites is warming, the variance shows little change.

4B04.2 ID:4051 **10:45**

Hydrodynamic phenomena in the Mackenzie Delta during Surge Event

Fumin Xu , *Will Perrie* , *Steve Solomon*
Bedford Institute of Oceanography

Contact: perriew@dfo-mpo.gc.ca

Storm surges in the Mackenzie Delta cause dramatic hydrodynamic disturbances on the surface of the subaerial delta plain, river network and the lakes that occupy the lower delta plain. Storm induced water level variations in the delta caused by: storm surge, wave set-down and set-up, tides, sea level changes due to river run off, and wave run-up. The tide is small (<0.37m), whereas the water level rise during a storm is wind induced storm surge (> 1.5 m) with wave set-up playing a secondary role. Increased open water season length and fetch due to decreasing sea ice will result in increased exposure to severe storms, surge and waves. Typical storms originate south and west of the region track eastward north of the Beaufort shoreline accompanied by northwesterly winds, that generate waves and high water levels. August to October is the period that is the most susceptible to these events. A typical event of 15-20 September, 1985 is chosen to study these storm surges. This storm was responsible for the destruction of an artificial oil exploration island built in 15 m water depth ~40 km NW of the delta. The SWAN model is applied to study the waves, calibrated with observations. The boundary conditions and wind forcing are extracted from reanalysis results from the Meteorological Service of Canada Beaufort Sea hindcast (MSCB). Using updated bathymetry our aim is to pursue a clear definition of the surf zone for the Mackenzie Delta through investigating the breaking wave fraction due to depth-induced breaking, water level set-down outside of the surf zone and set-up within the surf zone, storm wave actions on the bed, such as water particle orbital velocity near the bottom, storm wave composition in the delta area, and analysis potential sediment trasnport from storm wave action. We will also use a comprehensive model incorporating atmospheric and ocean circulation, changing sea ice, local geology, river network and estuary. The FVCOM model will be applied to the 1985 event, using an unstructured grid.

4B04.3 ID:3968 11:00

Impacts of air-sea interactions on an Arctic storm

Zhenxia Long , *William Perrie*
Bedford Institute of Oceanography
Contact: perriew@dfo-mpo.gc.ca

A coupled regional climate model (CRCM-CIOM) is implemented to study air-sea interactions during an Arctic storm. The storm originated near Siberian coast on July 28, 2008, slowly moved eastward and intensified, reaching maximum intensity in Canada Basin with a minimum pressure of 976hPa. During this period, the ice cover in Canada Basin was significantly less than the normal climatology. We investigate the impacts of the reduced ice cover on the storm.

CRCM-CIOM is composed of the Canadian Regional Climate Model (CRCM) and the Coupled Ice-Ocean Model (CIOM). The horizontal resolution is 25km for CRCM and about 27km for CIOM, and the time step is 15min. The model was

integrated from July 28 to August 10, 2008. Two experiments were performed. In the coupling run, CRCM provides CIOM with surface wind, air temperature and humidity, total cloud and sea level pressure; CIOM feeds back sea ice cover and SST. In the uncoupling run, CRCM uses the climatological ice cover and SST. Compared to CMC analyses and NCEP-QCSCAT data, the coupled system simulates the storm intensity and track well. In addition, the model captures the ice cover in Canada Basin well, but slightly overestimates the ice cover along the Atlantic area.

Comparisons between uncoupling and coupling runs enable us to understand the impacts of the reduced ice cover (in 2008) on the storm. Although the impact of the reduced ice cover seems small (about 2hPa), it significantly increases the maximum surface wind speed due to increased low-level instability. The horizontal distribution of wind speed shows that most of the impacts on wind speed occur in Canada Basin with a maximum increase of 5m/s. Further analyses suggest that increased low-level instability due to reduced ice cover is the main reason for the increased wind speed.

4B04.4 ID:4029 11:15

Development of a Modelling Capacity for the Canadian Arctic Archipelago

Paul Myers , *Qiang Wang* , *Xianmin Hu* , *Arjen Terwisscha Van Scheltinga*
Department of Earth and Atmospheric Sciences, University of Alberta
Contact: pmyers@ualberta.ca

A nested set of structured ocean/sea-ice general circulation models for the Arctic Ocean and the Canadian Arctic Archipelago have been developed. The models have been developed in the framework of the NEMO modelling system. Model configurations, forcings and results of preliminary simulations will be presented. The focus will be on the models ability to estimate fluxes through the Canadian Arctic Archipelago as well as present limitations. Results from an unstructured finite element model will also be presented.

4B04.5 ID:3995 11:30

Photoammonification: Implication for primary production in the southeastern Beaufort Sea

Huixiang Xie [1], *Guisheng Song* [1], *Marjolaine Blais* [2], *Simon Bélanger* [3], *Jean-Éric Tremblay* [2], *Marcel Babin* [4]
[1] Institut des sciences de la mer, Université du Québec à Rimouski
[2] Département de biologie and Quebec Ocean, Université Laval
[3] Département de biologie, chimie et géographie, Université du Québec à Rimouski
[4] Laboratoire d'Océanographie de Villefranche, CNRS & Univ. Pierre et Marie Curie
Contact: huixiang_xie@uqar.qc.ca

Photochemistry of chromophoric dissolved organic matter (CDOM) plays an important role in major marine biogeochemical cycles, including the regeneration of inorganic nutrients. CDOM photooxidation affects the nitrogen cycling by converting bio-refractory dissolved organic nitrogen to bioavailable inorganic nitrogen (e.g. ammonium) and through enhanced bacterial nitrogen demand. During the 2009 Mackenzie Light and Carbon (MALINA) program (http://www.obs-vlfr.fr/Malina/scientific_program.html), the absorbed photons-based efficiency spectra of ammonium photoproduction (i.e. photoammonification) were determined on water samples from the SE Beaufort Sea, including the Mackenzie River estuary, Mackenzie Shelf, and Canada Basin. Ammonium photoproduction efficiency decreased with increasing wavelength across the ultraviolet and visible regimes and was undetectable at > 500 nm. The efficiency was higher in offshore waters than in coastal and estuarine areas and was approximately inversely correlated with the absorption coefficient of CDOM at the ultraviolet wavelengths. The ammonium efficiency spectra, along with solar photon fluxes and CDOM absorption distributions, were used to model the surface and depth-integrated photoammonification rates. In the summer of 2009 photoammonification rates at the surface were 12.5 nmol L-1 d-1 on the Mackenzie Shelf and 5.4 nmol L-1 d-1 further offshore; rates integrated over the photic zone were correspondingly 7.0 µmol m-2 d-1 and 12.4 µmol m-2 d-1. The offshore rates could account for 36% and 8% of the total dissolved inorganic nitrogen uptake by phytoplankton at the surface and in the upper 10-m layer, respectively. This study suggests that photoammonification may fuel a previously unrecognized primary production pathway that is partly responsible for the continued decline of soluble reactive phosphorus and dissolved inorganic carbon after nitrate is depleted in the upper mixed layer of the southeastern Beaufort Sea.

4B04.6 ID:3847 11:45

Integrated pan-Arctic melt onset detection from satellite microwave measurements

Libo Wang [1], *Chris Derksen* [1], *Stephen Howell* [1], *Gabriel Wolken* [2], *Martin Sharp* [2], *Thorsten Markus* [3]

[1] Climate Research Division, Atmospheric Science and Technology Directorate, Environment Canada

[2] Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada

[3] Cryosppheric Sciences Branch, Code 614.1, NASA Goddard Space Flight Center, Greenbelt, MD

Contact: libo.wang@ec.gc.ca

An integrated pan-arctic melt onset dataset was produced by combining active and passive microwave satellite derived melt onset estimates from unique, previously published, algorithms developed for the northern high latitude land surface, ice caps, large lakes, and sea ice. Comparisons of melt onset along the boundaries between different components of the cryosphere show that the integrated dataset can provide consistent melt onset estimates in most arctic areas. In this paper, we present the climatology, trends, and the annual and inter-

annual anomalies in melt onset timing across the pan-arctic during the 2000 to 2009 period, and investigate the geographic and climatic controls on the observed melt patterns. Melt onset on land was closely correlated with spring surface air temperature, while melt onset on sea ice was mainly affected by surface wind associated with the atmospheric circulation over the Arctic. There were strong time-lagged correlations between anomalies in terrestrial snowmelt onset and summer sea ice extent, with a correlation peak in July (r=0.89), implying linkages between changes in arctic snow cover and sea ice during the spring period.

Cloud-Aerosol Interactions (Part 2) / Interactions nuages-aérosols (Partie 2)

Room / Endroit (Frontenac), Chair / Président (Knut von Salzen), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B05.1 ID:3966 **10:30**

Sensitivity responses to the piecewise log-normal approximation in a single column model and implementation into the GEM-AQ model

Jennifer Mclarty [1], *John C. Mcconnell* [1], *Jacek W. Kaminski* [1], *Knut Von Salzen* [2]
[1] York University
[2] CCCma, Environment Canada
Contact: mclarty@yorku.ca

The CCCma atmospheric single column model is employed using the computationally efficient piecewise log-normal approximation (von Salzen, 2006) as an aerosol distribution. Sensitivity tests are performed to determine the response of several microphysical processes and assumed mass and number distributions to size partitioning. The focus is optimizing the size spectrum resolution to determine any process and aerosol mode dependency. In addition, we discuss implications of the application of the piecewise log-normal approximation method in regional and global air quality modeling and first results of the inclusion of the piecewise log-normal approximation into the Global Environmental Multiscale Air Quality model (GEM-AQ) will be presented.

4B05.2 ID:3305 **10:45**

Automated analysis of cloud entrainment events in a LES model

Jordan Dawe , *Phillip Austin*
Department of Earth and Ocean Sciences, University of British Columbia
Contact: jdawe@eos.ubc.ca

A scheme for automated cloud tracking in an LES in conjunction with a scheme for calculating entrainment and detrainment directly from model mass fluxes are presented. The cloud tracking algorithm breaks clouds up into sub-units and uses overlaps with previous timesteps to track individual clouds. The entrainment calculation scheme linearly interpolates the location of the cloud surface in order to find the difference between the motion of air and the movement of the cloud surface. The values from the entrainment scheme have variability consistent with values calculated using bulk tracer budgets if the bulk tracer calculations are corrected for the presence of a shell of detrained cloud air, which strongly modifies the estimates of fluid exchanges. We use these two techniques in conjunction to diagnose probability distributions of entrainment events over cloud lifecycles.

4B05.3 ID:3873 **11:00**

Aerosol-cloud droplet closure in Arctic stratus using observations from the Indirect and Semi-Direct Aerosol Campaign (ISDAC)

Michael Earle [1], *Peter Liu* [1], *Steve Ghan* [2], *J. Walter Strapp* [1], *Alla Zelenyuk* [2], *Mikhail Ovchinnikov* [2], *Don Collins* [3], *Anne Marie Macdonald* [4], *Nicole Shantz* [1], *W. Richard Leaitch* [5]
[1] Cloud Physics and Severe Weather Research Section, Environment Canada
[2] Pacific Northwest National Laboratory
[3] Texas A&M University
[4] Air Quality Processes Research Division, Environment Canada
[5] Climate Research Division, Environment Canada
Contact: Michael.Earle@ec.gc.ca

The contribution of atmospheric aerosol particles to Arctic cloud microphysics is investigated through a droplet number closure study using aircraft observational data from the US Department of Energy ISDAC study conducted in Alaska in April, 2008. Cloud droplet activation and growth are simulated in an adiabatic parcel model using input from below-cloud-base aerosol size distributed concentration and composition measurements as well as concurrent atmospheric state observations. The below-cloud aerosol particle measurements were obtained with a Passive Cavity Aerosol Spectrometer Probe (PCASP; size range 0.1 – 3 µm) and SPLAT, a single particle mass spectrometer. The vertical (updraft) velocity in the parcel model defines the rate of cooling and the initial development of the supersaturation, which dictates the onset of droplet nucleation. The vertical velocity is determined from a combination of in situ observations and updraft trajectories computed using a large eddy simulation cloud-resolving model (LES-CRM). The simulated droplet concentrations are compared against in situ measurements from a Cloud Droplet Probe (CDP; size range 2 – 50 µm) and/or Forward-Scattering Spectrometer Probe (FSSP-096; size range 5 – 95 µm). A case study is used to illustrate the droplet closure analysis for a flight on April 26, in which measurements were obtained below and within single-layer stratus in the vicinity of Barrow, Alaska. The SPLAT measurements for this case indicate that the below-cloud aerosol was composed

largely of organics (including biomass burning products) with contributions from sulphates and sea salt. The sensitivity of the comparison of simulated and observed cloud droplet number concentrations is examined for reasonable variations of the aerosol properties, physicochemical properties of the solution droplets (e.g. mass accommodation coefficient), and updraft velocity. The results increase our knowledge of factors affecting the lifetime and radiative properties of Arctic stratus, which are critical to our understanding of the role of climate change in the Arctic.

4B05.4 ID:3720 11:15

Characterization of the CCN Properties of Organic-Bearing Particles through In-Situ Measurements at a Rural Site

Jon Abbatt [1], *Rachel Chang* [1], *Nicole Shantz* [2], *Jay Slowik* [1], *Richard Leaitch* [2]
[1] University of Toronto
[2] Environment Canada
Contact: jabbatt@chem.utoronto.ca

In-situ measurements of CCN numbers and droplet growth kinetics were made at Environment Canada's Centre for Atmospheric Research Experiments at Egbert, ON in early summer 2007. Complementary measurements included gas-phase tracers, and aerosol composition and size. In order to determine the overall hygroscopicity of the oxygenated organic content of the aerosol, the numbers of CCN that were measured were compared to those predicted with a Kohler model. Within the model, the inorganic components of the aerosol were given a known hygroscopicity constant whereas that for the organics was varied in order to give the most consistent data set across the full set of composition. For the full study, this approach indicated that the hygroscopicity constant for the organics is quite large, on the order of 0.2. This is consistent with the oxygenated organic components being soluble with a relatively low molecular weight. In addition, we observed the growth kinetics of droplet formation, during periods of either biogenic or anthropogenic influence on the air mass. Somewhat surprisingly, the growth kinetics were faster during the biogenic periods than the more polluted times. We discuss all these results within the general context of the role that organic-bearing particulates play in cloud droplet formation in the atmosphere.

4B05.5 ID:3364 11:30

Aerosol variability in the Arctic during ISDAC from aircraft measurements

Nicole Shantz [1], *Ismail Gultepe* [1], *Peter Liu* [1], *Michael Earle* [1], *Alla Zelenyuk* [2]
[1] Environment Canada
[2] Pacific Northwest National Laboratory
Contact: Nicole.Shantz@ec.gc.ca

The objective of this work is to show the importance of the variability in aerosol total number concentration (Na) for cloud and climate studies. Observations were made during the Indirect and Semi-Direct Aerosol Campaign (ISDAC) which took

place in the vicinity of the Department of Energy Atmospheric Radiation Measurement (ARM) North Slope of Alaska (NSA) site in April, 2008. Some measurements were also collected over Fairbanks and during transit flights from Fairbanks to Barrow. Instruments mounted on the NRC Convair-580 aircraft and ground-based sensors at the NSA site were used to obtain measurements related to aerosol, cloud, radiation, and conventional meteorological parameters. This work focuses on the aerosol measurements in cloud-free regions obtained from a Passive Cavity Aerosol Spectrometer Probe (PCASP) mounted on the aircraft (which measures Na and size distribution in the size range 0.13-3 µm diameter) and a single particle mass spectrometer (SPLAT) located inside the aircraft (which measures chemical composition, Na and vacuum aerodynamic size distribution in the size range 0.05-1 µm diameter). Vertical profiles of Na and size distribution were studied in various meteorological conditions from 15 flights that included polluted and clean environments. Preliminary results from the PCASP show that the mean Na over all clean case vertical profiles was 120 cm-3 with a standard deviation (s.d.) of 40 cm-3 between 0.5 km and 6.5 km. When air masses were from biomass burning sources to the west (e.g. Russia) on April 18-22, the mean Na +/- s.d. was 720 +/- 360 cm-3 over the same layer. There was also a large variation of Na over constant altitude flight legs. For a polluted case on April 19, 2008, the mean Na +/- s.d. was 656 +/- 191 cm-3 at 5.5 km, Na=636 +/- 292 cm-3 at 4.5 km, and 1029 +/- 446 cm-3 at 2.9 km, demonstrating the large variability. It is concluded that aerosol number concentration variability should be considered in cloud and climate simulations, and can significantly affect Arctic heating/cooling processes.

Weather and Climate Monitoring in Canada - Current operations and future directions (Part 2)/ Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 2)

Room / Endroit (Joliet), Chair / Président (Alexandre Fischer and Tomasz Stapf), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B06.1 ID:3749 **10:30**

Climate research requirements with regard to precipitation monitoring

Eva Mekis , *Ewa Milewska*
Environment Canada

Contact: eva.mekis@ec.gc.ca

Precipitation is among the most important parameters to observe for climate monitoring due to its direct effect on human society. The assessment of climate trends and detection of climate change is based on the studies of indicators that require good quality long term observations. Since about 1990, there has been serious degradation of the monitoring network due to station closure and a trend toward automation. The variety of gauges with different orifice height and diameter, windshields and resolution used at different time periods along with different reporting practices are the cause of uncertainty in the historical continuity of observations. In particular, large biases associated with catchment efficiency of solid precipitation can greatly affect compatibility of measurements. It may be difficult at time to distinguish solid and liquid precipitation at automated stations, which currently report only total precipitation. Both rain and snow observations need to be adjusted to remove any artificial discontinuities caused by station relocation, changes in instrumentation and observing procedures. Metadata, or detailed information about station siting, observing practices, instrument changes, performance, calibration and maintenance is crucial in the process. A minimum of two to five years of concurrent observations proves very useful in developing transfer functions from the old to the new set of observations, e.g. human and automated, to preserve continuity of long-term series. The current status and difficulties related to precipitation observations will be discussed from the perspective of climate research users.

4B06.2 ID:3536 10:45

Performance of Present Weather Sensors as Precipitation Gauges

Kai Wong
Environment Canada
Contact: kai.wong@ec.gc.ca

In addition to determining the types of weather, a present weather sensor (PWS) also reports on the precipitation amount and rate, thus it can function as a precipitation gauge. In this work, the performance of PWS operating as precipitation gauges is studied. The PWS in this study include OTT Parsivel and Vaisala PWD22. The precipitation accumulations reported by these PWS are compared to that of a number “traditional” precipitation gauges, with a Geonor gauge in a WMO double fence serving as a reference. To gain a broader perspective, the comparison is carried out under various conditions such as different precipitation types and intensities. It is hoped that the results will help to shed light on the question of whether a PWS can be a viable replacement of a traditional precipitation gauge.

4B06.3 ID:3496 11:00

Canadian Automated Snow Depth Measurements: A User's Perspective

Bruce Brasnett

Canadian Meteorological Centre
Contact: Bruce.Brasnett@ec.gc.ca

With the trend toward automating surface observing in Canada, there has been a dramatic increase in the number of snow depth observations produced by automatic instruments. Observations by human observers now account for only 35% of Canadian snow depth observations. The Canadian Meterological Centre is a major user of these data. Snow cover/depth is an important parameter for numerical weather prediction. In this paper, results of a study of the quality of snow depth observations will be presented. Typical errors in automated snow depth reports will be examined, their impact on CMC operations will be discussed and remedial actions will be described.

4B06.4 ID:3510 11:15

On the characteristics of snowflakes falling inside a snow gauge

Julie M. Thériault , *Scott Landolt* , *Kyoko Ikeda* , *Roy Rasmussen* , *Al Jachcik* , *Sara Ziegler*
National Center for Atmospheric Research
Contact: theriaul@ucar.edu

Accurately measuring snowfall amounts can be critical for a wide variety of studies including snowpack, climate variability and hydrology. It has been recognized that systematic errors in snowfall measurements are often observed due to the gauge geometry and the weather conditions. For example, the higher the wind speed during a snowfall event, the lower the collection efficiency of the snow gauge. The collection efficiency of snow gauge can be increased if a wind shield is installed around it. The airflow around the gauge varies depending on the wind speed, which influences the trajectory of the falling snowflakes. Since the gauge and the shield are obstacles to the natural airflow pattern, smaller and lighter snowflakes may interact with the gauge and shield differently than larger flakes. To address this, a study was undertaken to determine if different types and sizes of snowflakes fall inside versus outside of a GEONOR snow gauge. Additionally, snowflakes were collected both with and without a shield around the gauge. The collected snowflakes were photographed and the pictures analyzed to determine their characteristics. Finite element modeling was used to simulate the flow around the snow gauge and study the trajectory of various crystal types falling through the atmosphere. The model results were then compared with observations. Preliminary results show that the snowflake characteristics are different depending on their location relative to the gauge and the wind speeds during the event.

4B06.5 ID:3725 11:30

Monitoring Wind Profiler Data from the Canadian O-Q Network with the MSC Forecast Systems

Judy St-James , *Stéphane Laroche*

Environnement Canada
Contact: Judy.St-James@ec.gc.ca

Wind observations from the Ontario-Quebec Profiler Network (O-QNet) are assessed in preparation for their assimilation in the Meteorological Service of Canada (MSC) data analysis system. This network of over 10 VHF wind profilers is under construction in Ontario and Quebec. These radars operate at a frequency in the range of 40 to 55MHz and provide hourly average measurements of horizontal wind vectors. For the moment, the MSC is receiving data from approximately half of the wind profilers in real time. As a first step, a close monitoring is performed during the 2010 winter season by comparing the observations (O) and short-range forecasts (F). The bias and rms of the O-F are calculated for every profiler to assess the overall quality of the observations provided by each profiler station. Secondly, horizontal winds from three upper-air stations (Eureka, Detroit and Maniwaki), considered as high quality observations, are compared with the Eureka, Harrow and McGill wind profiler measurements. As was previously done for NOAA's Profiler Network (St-James and Laroche, 2005), the vertical correlation structure of the O-QNet wind profiler observation error is examined. Since the MSC analysis scheme does not take into account observation error correlations, a vertical thinning might be required to properly assimilate these observations.

4B06.6 ID:3367 **11:45**

Methane emissions from a municipal waste centre, as deduced by inverse dispersion

John Wilson [1], *Thomas Flesch* [1], *Raymond Desjardins* [2]
[1] University of Alberta
[2] Agriculture and Agri-Food Canada
Contact: jaydee.uu@ualberta.ca

During November 2009, several open path lasers were deployed to ascertain path-averaged methane concentrations in the near vicinity of lagoons and compost piles at the Edmonton Waste Management Centre. Simultaneous wind and turbulence measurements permitted the estimation of methane emission rates from the diverse sources, on the basis of computed backwards-in-time particle paths originating in the beam of the laser detector. Although this was an exploratory study, it established the practicability of the laser-based inverse dispersion approach in a complex environment with multiple sources.

Operational sea-ice analysis and prediction (Part 1) / Analyse opérationnelle et prévision des glaces de mer (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Roger De Abreu), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B07.1 ID:4108 **10:30**

The motivation and requirements for operational sea ice analysis and forecasting systems in Environment Canada

Tom Carrieres , *Lynn Pogson*
Marine and Ice Services Division, Environment Canada
Contact: Mark.Buehner@ec.gc.ca

Sea ice affects much of Canada's coastline and inland waters. Accurate ice information is crucial for the marine community and it is also important for weather forecasting and climate simulation. While the information required by each of these three applications, in terms of temporal and spatial scales and content, is quite different, there are also similarities that warrant close collaboration amongst researchers in each field. For example, sea ice data assimilation systems developed for operational ice forecasting will also be used to provide larger scale sea ice analyses for numerical weather prediction. Sea ice models designed for climate modelling are also adapted and used for ice forecasting. The requirements for sea ice information for each of these three areas within Environment Canada will be reviewed in order to provide some context for the presentations to follow in this session.

4B07.2 ID:4066 **10:45**

Advanced Remote Sensing for Better Bottom-fast Ice Identification

Joseph Chamberland , *Bing Yue* , *Garrett Parsons* , *John Mulvie*
C-CORE
Contact: joseph.chamberland@c-core.ca

As development and exploration in the Mackenzie Delta increases, it is essential to concurrently develop adequate tools to ensure the safety and security of those working in harsh northern conditions. The ability to accurately delineate bottomfast ice (BFI) zones in the Mackenzie Delta region of the Beaufort Sea using remote sensing is an interesting application as this type of ice is used extensively for transportation during the winter months. During a previous project called Mackenzie Delta Environmental Monitoring (MDEM), spaceborne SAR sensors were shown to have potential in accurately identifying these ice regions and discriminating BFI from floating sea ice. Through increased focused research

and application development, advanced techniques have been tested to discriminate further between different types of ice that are typical to the Mackezie Delta. Through the fusion of polarimetric and Interferometric data analysis, it will be shown that it is now possible to discriminate between previously problematic regions and that the overall picture of BFI formation and extent is becoming less mysterious.

4B07.3 ID:3861 11:00

Modelling of Synthetic Aperture Radar Features for Sea-Ice Analysis and Forecasting

Gokhan Kasapoglu [1], *Tom Carrieres* [2], *Mark Buehner* [3]
[1] Canadian Ice Service
[2] Marine and Ice Services Division, Environment Cana
[3] Meteorological Research Division, Environment Cana
Contact: Gokhan.Kasapoglu@ec.gc.ca

Synthetic Aperture Radar (SAR) is an active sensor system which has the capability to monitor relatively large areas of the Earth's surface both in day and night time. Electromagnetic waves penetrate clouds, and therefore the presence of clouds does not limit monitoring. Together with its high spatial resolution, these characteristics make SAR data a very important source of information for sea ice monitoring.Tone and texture are two main feature sources that can be used for SAR image interpretation and modeling. In this study, co-occurrence matrix based feature extraction method used to extract texture features from Radarsat-2 Scansar dual band data. Not only texture features but also tonal features were used in the experiments. A forward model was used to simulate extracted SAR features by using some sea-ice features such as ice concentration, ice thickness and some geophysical parameters such as wind speed and direction, snow depth and air temperature. Some parameters related to SAR imaging geometry such as incidence and instrument angles were also taken account to build a robust model.

4B07.4 ID:3745 11:15

Information content of AMSR-E and AVHRR data for estimating sea-ice concentration

Andrea Scott [1], *Mark Buehner* [1], *Tom Carrieres* [2]
[1] Meteorological Research Division, Environment Canada
[2] Marine and Ice Services Division, Environment Canada
Contact: andrea.scott@ec.gc.ca

Two different types of observations are currently being investigated for use within a three-dimensional variational data assimilation system (3D-Var). The purpose of this work is to obtain an accurate estimate of sea ice concentration for ice forecasts and also for numerical weather prediction. The first type of observation is passive microwave brightness temperatures from AMSR-E, and the second

type of observation is albedos and brightness temperatures from a visible/infrared sensor, AVHRR. These two types of observations differ in that the passive microwave sensor is able to see through clouds and at nighttime, but has a fairly coarse resolution (75 km - 5 km), while the visible/infrared sensor cannot see through clouds or during the nighttime, but has a relatively fine resolution (1km). Results will be presented demonstrating the information content for each type of observation and its dependence on atmospheric state and sea ice condition. The implications of these results on the assimilation of each type of observation will be discussed

4B07.5 ID:3700 11:30

A Study of Long-term Sea Ice Conditions in the Northwest Passage for Determination of Ship Transits

David Fissel , *Mar Martínez De Saavedra Álvarez* , *Todd Mudge* , *John Marko*
ASL Environmental Sciences Inc
Contact: dfissel@aslenv.com

An analysis was carried out to determine the duration of the summer shipping season for deepwater vessels transiting through the Northwest Passage Route. The Northwest Passage is the shipping route between the Atlantic Ocean (Baffin Bay) to the Pacific Ocean (Bering Sea). The most likely route segment to obstruct shipping is the western portion of Parry Channel where the region is typically characterized by the presence of high concentration mixtures of deformed, thick first year and multiyear ice in Viscount Melville Sound and its adjacent passages, including the very narrow Prince of Wales Strait. Based upon the historic data, the blockage and delay problems in these areas are sufficiently serious as to preclude extended duration shipping seasons except for occasional exceptional years. On the other hand, recognized possibilities for dramatic climate change-induced amelioration of Arctic ice conditions combined with several occurrences of the needed exceptional conditions during the last decade, has encouraged a more optimistic view of Northwest Passage traversal prospects. The times of ship transits through the passage is determined from the computer-based analysis of digital Canadian Ice Service weekly ice charts which are available from the late 1960’s to the present. The criteria for successful ship transits is based on specified maximum partial ice concentrations by ice type with high concentrations of old ice combined with thick first year ice representing the limiting conditions to ship transits. The results show a very large year to year variability in the duration of the summer shipping season with the trend towards slightly improving ice conditions. The possibility of future increases in old ice concentrations in western and central portions of Parry Channel due to an apparent trend towards more rapid passage of this old ice through the Queen Elizabeth Islands to the north will be discussed.

4B07.6 ID:3881 11:45

Verification of Canadian East Coast Ocean (Ice) Model (CECOM)

Hai Tran [1], *Alexander Kamarov* [2]
[1] Canadian Ice Service
[2] MSC, EC
Contact: Hai.Tran@ec.gc.ca

The new coupled Ocean-Sea Ice model (CECOM) has been implemented at the CIS with the purpose of replacing the existing CIOM (Community Ice Ocean Model). This new model covers larger domain with higher resolution. The test run has been carried out during year 2008/2009 season, the results are verified against the CIS tracking system and the conclusions are made.

Polar Climate Stability (Part 2) / Stabilité du climat polaire (Partie 2)

Room / Endroit (Capitale), Chair / Président (Shawn J. Marshall), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B08.1 ID:3455 10:30

Improved methods for estimating subglacial topography and ice volume applied to glaciers of northwestern North America

Garry Clarke , *Eldad Haber* , *Faron Anslow* , *Valentina Radic* , *Alexander Jarosch*
Earth & Ocean Sciences, University of British Columbia
Contact: clarke@eos.ubc.ca

The present volume, and thus the potential contribution to sea-level rise, of Earth's ~160,000 mountain glaciers is largely based on the application of volume–area scaling relationships which cannot yield information about subglacial topography. This is a serious shortcoming because such knowledge is required for computer simulations of the dynamic response of glaciers to climatic change and thus for projecting the local and regional impacts of rapid deglaciation. We have examined a variety of approaches to estimating subglacial topography from surface data. Methods that use only a digital elevation model and ice mask require the least information but are subject to large errors. Two promising new methods that exploit, in different ways, the surface mass balance field have been cast in the framework of geophysical inverse theory. One is based on an assumption of ideal but spatially-varying ice plasticity and the other on a standard Glen-law ice flow rheology. We demonstrate these methods by applying them to glaciated regions of the Yukon and British Columbia.

4B08.2 ID:3880 10:45

An Unstructured Grid Glacial Modeling Framework

Gordan Stuhne , *W. R. Peltier*
University of Toronto
Contact: gordan@atmosp.physics.utoronto.ca

We will report progress in the development of a new unstructured grid glacial model. The model physics are based upon the University of Toronto Glacial Systems Model, while the code base and numerical techniques stem from our previously published work on global ocean and tidal modeling. Finite volume techniques that we employed in earlier work have been generalized to discontinuous Galerkin techniques, which allow for higher-order accuracy and for natural coordinate systems on curved manifolds. The use of unstructured grids in an ice-modeling context is motivated, amongst other considerations, by the desirability of concentrating resolution in critical regions like ice margins and ice streams. Locally enhanced resolution also allows for the optimal exploitation of ever-improving observational data, and we aim to use the model to improve hindcasts of the paleoclimate history of Greenland (under the established EISMINT protocols). Preliminary numerical tests using an isothermal shallow-ice version of the model are being extended to more complex cases involving 3-D thermomechanical ice-sheet dynamics, and the latest available results will be presented at the conference.

4B08.3 ID:3326 **11:00**

Quantifying Holocene Climates of the Canadian Arctic

Konrad Gajewski , *Andre Viau*
University of Ottawa
Contact: gajewski@uottawa.ca

Significant changes in high-latitude climates have been observed over the past 50 years mainly in response to human greenhouse gas forcing. However, the dynamics of past climate variability in these regions remain poorly resolved, making it difficult to assess the modern polar climate stability in relation to the current warming. Studies have shown that the early Holocene was warm across the Arctic, but existing information remains qualitative. Paleolimnological reconstructions have suggested that the past few centuries are “unprecedented”, but these records are poorly dated and there are questions about their interpretation. Attempts at quantitative terrestrial syntheses have been restricted to the past 2000 years. Recent pollen syntheses and paleolimnological reconstructions are presented that quantify the temperatures of the early Holocene warm period of the Canadian Arctic. The warming was widespread, and had large impacts on the ecosystems of the region. When compared to regional and sub-continental Holocene reconstructions from the Boreal and Beringian regions and more generally to the entire North American continent, we show that the dynamics of climate variability is more complex in response to natural forcings of the past.

4B08.4 ID:4075 **11:15**

The impact of greenhouse gas forcing and ocean circulation changes on permanent snow cover during past climate conditions favourable to glacial inception

Guido Vettoretti , *Richard Peltier*
University of Toronto
Contact: g.vettoretti@utoronto.ca

The accumulation of permanent snow cover over high-latitude regions during past climate conditions that were favourable to continental ice sheet growth is investigated using the NCAR CCSM3 global coupled climate model. Two periods of Earth's insolation history, the pre-industrial period and Marine Isotopic Stage (MIS) 5e/5d, are used as benchmarks for the accumulation of permanent summer snow cover. A series of millennial scale sensitivity experiments at two different resolutions are performed to demonstrate the relative importance of atmospheric greenhouse gas forcing (at the millennial scale) and ocean overturning strength (at the century scale) in driving the response of the high-latitude cryosphere. We present results of the correlations between Atlantic meridional atmospheric heat and moisture transport to high-latitude regions and polar snow cover. In addition to this a series of atmospheric greenhouse gas concentration levels are used to demonstrate the existence of thresholds in the evolution of the state of the cryosphere.

Regional Climate Modelling (Part 3) / Modélisation régionale du climat (Partie 3)

Room / Endroit (Panorama), Chair / Président (Ramon de Elia), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B09.1 ID:3405 **10:30**

Internal Variability of the Canadian Regional Climate Model and Singular Vectors

Emilia Paula Diaconescu [1], *René Laprise* [1], *Ayrton Zadra* [2]
[1] Canadian network for Regional Climate Modelling and Diagonstics, University of Québec at Montréal
[2] Meteorological Research Division, Environment Canada
Contact: diacones@sca.uqam.ca

Previous studies showed that Regional Climate Model (RCM) internal variability fluctuates in time depending on synoptic events. In this study, we focus on the

physical understanding of episodes with rapid growth of internal variability. The hypothesis is that internal variability is arising through rapid-growing perturbations developed in unstable regions. Singular vectors are generally able to capture atmospheric regions and periods characterized by large hydrodynamical instability.

An ensemble of 10 simulations, differing only in the initial conditions, was run over the North America using the Canadian RCM version 5 (CRCM5). The internal variability (IV) is defined as the spread between the members of CRCM5 ensemble during the integration period and measured in terms of total energy of CRCM5 perturbations. Several series of singular vectors were computed to identify the orthogonal set of perturbations that provide the maximum linear growth with respect to the total-energy norm during the course of the CRCM5 evolution. RCM perturbations were then projected onto the space of singular vectors. The analysis of one case of rapid growth of IV (December 1992) is presented in detail. We find that a large part of the IV growth is explained by initially very small unstable perturbations represented by the SVs.

4B09.2 ID:3635 **10:45**

Evaluation of the Internal Variability and estimation of the Downscaling Ability of the Canadian Regional Climate Model for different Domain Sizes over the North Atlantic region using the Big-brother Experimental approach

Maja Rapaic , *Martin Leduc* , *René Laprise*
UQAM
Contact: rapaic@sca.uqam.ca

Ability of a nested model to accurately simulate Arctic's climate as the most affected by anticipating anthropogenic climate changes is studied here. Two issues have been investigated: models internal variability (IV) and domain size (DS). For this purpose we combine the "perfect model" approach, Big- Brother Experiment (BBE) (Denis et al., 2002) with the ensemble of simulations. The advantage of this framework is the possibility to study small-scale climate features that constitute the added value of RCM. Effects of the DS on result were studied by employing two Little-brothers (LBs). IV has been evaluated by introducing small differences in initial conditions in an ensemble of twenty simulations over each LB.

Results confirm previous findings that the IV is more important over the larger domain of integration (Alexandru et al., 2007). The temporal evolution over two domain sizes is rather different and depends strongly on the synoptic situation. Small-scales solution over the larger domain diverges freely from the boundary forcing in some periods. Over the smaller domain, the amplitude of small-scale transient eddies is largely underestimated, especially at higher altitude characterized by the strongest winds along the storm tracks. Over the larger domain, small-scale transient eddies are better represented. However, the

weaker control by the lateral boundaries over the larger domain results in solutions with large internal variability. Consequently, the ensemble average strongly underestimates the transient- eddy variance due to partial destructive interference of individual ensemble member solutions.

4B09.3 ID:3337 11:00

Improving regional climate change projections of temperature for Halifax, Nova Scotia via a new statistical downscaling approach.

Matthew Lee Titus
Environment Canada
Contact: Lee.Titus@ec.gc.ca

In order to best assess the expected climate change impacts on a species, ecosystem or natural resource in a region, climate variables and climate change scenarios must be developed on a regional or even site-specific scale (Wilby et al, 2002). To provide these values, projections of climate variables must be downscaled from the GCM results, utilizing either dynamical or statistical methods (IPCC, 2001).

This study proposes a new statistical downscaling approach as an improvement on a current technique. This proposed new method of regression development is compared with the regression achieved via the Statistical Downscaling Model Software (SDSM; Wilby et al). Observed daily maximum temperature (Tmax, the predictand), taken from Shearwater airport (used as a proxy for Halifax, NS) was selected as the variable to be downscaled in winter (DJF). The predictand and predictors (taken from the NCEP Reanalysis) were turned into Z scores. The seasonal cycle was removed from each to get the seasonal anomalies. Then a predictor selection process was employed to remove predictors that are not useful or redundant. Next, the principal components (PC's) of the predictors from NCEP were calculated for the historical period (1961-2000). The regression was trained on the PC's from 1961-1990 and then validated by predicting 1991-2000 Tmax. For comparison, downscaling was done with SDSM for the same location and time period. The SDSM regression was again trained on the 1961-1990 data and then validated on the 1991-2000 period. The observed seasonal cycle was removed from the SDSM downscaled Tmax to obtain the seasonal anomaly. The Tmax seasonal anomaly for winter (1961-2000) projected by both the new method and SDSM were compared against observations. The new method exhibited a correlation of 0.86 with observations. This is almost a 0.3 increase in the correlation value between SDSM and observations. This indicates that the new method is a major improvement to the SDSM software method.

4B09.4 ID:3534 11:15

High resolution monthly temperature scenarios over North America

Guilong Li [1], *Xuebin Zhang* [2], *Francis Zwiers* [2]

[1] Atmospheric Science and Application Unit — MSC Ontario Region, Environment Canada
[2] Climate Research Division — ASTD, Environment Canada
Contact: Guilong.Li@ec.gc.ca

This presentation provides a framework in which dynamical and statistical downscaling methods are combined to construct monthly temperature scenarios over North America at 45x45 km resolution. Monthly temperatures from NCEP Reanalysis II data are dynamically downscaled by six regional climate models (RCMs) participating the North America Regional Climate Change Assessment Program. The dynamically downscaled high resolution temperature and low resolution NCEP Reanalysis II temperature for the period of 1979-2004 are then used to establish statistical models to link small scale and large scale temperatures. These statistical models are then applied to GCM projected future temperature changes available from the CMIP3 database, to construct high resolution monthly temperature scenarios for North America. Uncertainties due to GCM structural errors, difference in RCMs, and internal variability are analyzed. The end product provides projected monthly temperature changes in the future at 45 km resolution with different uncertainty ranges.

4B09.5 ID:3425 11:30

Diagnostic budget study of the Internal Variability in ensemble simulations of the Canadian Regional Climate Model

Oumarou Nikiema [1], *René Laprise* [2]
[1] student
[2] Professor, Dept. Earth and Atmospheric Sciences, UQAM
Contact: nikiema@sca.uqam.ca

Due to the chaotic and nonlinear nature of the atmospheric dynamics, it is known that the small differences in the initial conditions (IC) of models can grow and affect the simulation evolution. In this study, we perform a quantitative diagnostic budget calculation of the various diabatic and dynamical contributions to the time evolution and spatial distribution of internal variability (IV) in simulations with the nested Canadian Regional Climate Model. We establish prognostic budget equations of the IV for the potential temperature and the relative vorticity fields. For both of these variables, the IV equations present similar terms, notably terms relating to the transport of IV by ensemble-mean flow and to the covariance of fluctuations acting on the gradient of the ensemble-mean state. In practice, we show the skill of these equations to diagnose the IV that took place in an ensemble of 20 three-month (summer season) simulations that differed only in their IC. Our study suggests that the dominant terms responsible for the large increase of IV are either the covariance term involving the potential temperature fluctuations and diabatic heating fluctuations, or the covariance of inter-member fluctuations acting upon ensemble-mean gradients. Our results also show that, on average, the third-order terms have little contribution, but they can become important when the IV is large.

4B09.6 ID:3991 **11:45**

Central South-West Asian precipitation: results from AMIP models

Khalid Malik [1], *Peter Taylor* [1], *Kit Szeto* [2]
[1] York University
[2] Environment Canada
Contact: kmmalik@yorku.ca

Annual, monthly and spatial precipitation patterns of Atmospheric Model Inter-comparison Project (AMIP) simulations over the Central South-West Asia (25-40N and 45- 75E) region (CSWA) are compared with GPCC (Global Precipitation Climatology Centre) monthly precipitation data for the period of 1979-2001. GPCC precipitation data for CSWA are well correlated with observational precipitation data with a correlation factor of 0.953. The region is divided into three sub-regions based on topography: 1.The west region with less elevated mountains which receives mostly stratiform precipitation, 2.The central region with uneven rocks and deserts which receives convectional precipitation and 3.The eastern region with high mountain ranges and glaciers which receives orograpic precipitation. The models show large variations in capturing the seasonal precipitation, although spatial correlations indicate that some of the models simulate the pattern of GPCC precipitation fields fairly well. Some models cannot capture the convection precipitation which occurs during spring (March-April) and autumn (September-October). Most of the models predicted well in winter compared to GPCC data whereas some models do not adequately capture the summer (monsoon) precipitation which enters the domain from the east along the Himalaya ranges. On the space scales of the selected region, there is little consistent evidence that points to any specific model feature as a predictor of model performance. None of the obvious candidates such as horizontal resolution, convective closure schemes, or land surface schemes are reliable discriminators of a models ability to simulate precipitation. In the inter-mountain region, high horizontal resolution models do better that low resolution models. However, there is not enough evidence to produce a reliable discrimination on this basis. The correlation coefficient of observed precipitation with model output can be improved by making adjustments according to the mean of the correlated model precipitation predictions.

Carbon Cycling of Canadian Forests and Peatlands (Part 1) / Cycle du carbone des forêts et tourbières canadiennes (Partie 1)

Room / Endroit (Pinnacle), Chair / Président (J.H. McCaughey), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B10.1 ID:3647 INVITED/INVITÉ 10:30

The CCP-Fluxnet Canada network and the interplay between energy, water and carbon uptake in the landscape

Garth Van Der Kamp , *Alan Barr*
Environment Canada
Contact: garth.vanderkamp@ec.gc.ca

The atmospheric fluxes of energy and water measured by the CCP/Fluxnet Canada network provide highly valuable data for studies of hydrology and land-atmosphere interactions. The data are being increasingly utilized for such applications, and there is potential for much more such use. On the other hand the soils and hydrological conditions in the landscape exert a controlling influence on the distribution of vegetation types and on the carbon uptake. Hydrology, topography and surficial geology thus provide a framework for up-scaling of tower flux data in time and space. The basic physics requirement for closure of energy and water balances also imply the possibility of using water balance estimates as an independent check on flux data. The linkages in the landscape between hydrology and vegetation are especially clear in the semi-humid Boreal Plains forest of central Saskatchewan where the BERMS flux towers are located. The concentration of long-term flux towers in the BERMS area, located within each of the major vegetation types, constitutes a unique test bed for development and validation of conceptual and numerical models of the interplay between energy water, and carbon uptake in the landscape.

4B10.2 ID:3653 11:00

Seasonal Differences in the Sensitivities of CO2 and Water Vapour Fluxes to Climatic Forcings at Three Boreal Forest Ecosystems in Central Saskatchewan

Alan Barr [1], *Andy Black* [2], *Harry Mccaughey* [3]
[1] Environment Canada
[2] U.B.C
[3] Queen's U.
Contact: alan.barr@ec.gc.ca

Inter-annual variations in the ecosystem–atmosphere exchanges of carbon, water and energy are often related to particular seasons when the fluxes are highly sensitive to inter-annual climate differences. This study analyzes seasonal “hotspots” in the sensitivities of net ecosystem production NEP and evapotranspiration ET to temperature and moisture, based on multi-year eddy-covariance data from mature trembling aspen, black spruce and jack pine stands in central Saskatchewan. The sites have operated as part of the Boreal Ecosystem Research and Monitoring Sites, Fluxnet-Canada and Canadian Carbon Program networks. At all three sites, the seasonal cycles of NEP and ET were tightly coupled to the seasonal cycle of soil temperature, with a characteristic difference between evergreen-needleleaf and deciduous-broadleaf forests in the timing of the spring and fall transitions. Spring temperature was the

primary climatic control of annual NEP at all three sites, through its influence on the onset of the growing season. Its impact was 2-3 times greater at the deciduous-broadleaf than the evergreen-needleleaf sites. Precipitation and soil water content had significant but secondary influences on the annual carbon fluxes, particularly via the negative impact of mid-summer drought. In general, NEP had a more distinct response than ET to inter-annual climatic differences.

4B10.3 ID:3473 11:15

Disturbance and carbon fluxes of Canadian forests

Carole Coursolle [1], *Hank Margolis* [1], *Marc-André Giasson* [1], *Brian Amiro* [2], *Altaf Arain* [3], *Alan Barr* [4], *Andy Black* [5], *Mike Goulden* [6], *Harry Mccaughey* [7]
[1] Université Laval
[2] University of Manitoba
[3] McMaster University
[4] Environment Canada
[5] University of British Columbia
[6] University of California
[7] Queen's University
Contact: carole.coursolle@sbf.ulaval.ca

Net ecosystem productivity (NEP), gross ecosystem productivity (GEP) and ecosystem respiration (ER) of 26 forest stands across Canada were evaluated using the eddy covariance technique over a five-year period (2003-2007). This included ten black spruce, seven jack pine, three Douglas fir stands and one each of aspen and mixed-wood forest, as well as four white pine plantations ranging in age from 2- to 170-years old. The white pine plantations were generally sinks, while the other forest stands were generally carbon sources until about 9 - 18 years of age, weak to moderate sinks (50 - 400 g C m^{-2} yr^{-1}) from 19 to 80 years of age and carbon neutral or weak sinks (11 - 44 g C m^{-2} yr^{-1}) thereafter. Using these data, we estimate that, depending on species, forest stands in Canada would offset initial carbon losses after 19 - 43 years, and show net gains of 40 - 126 Mg C ha^{-1} at 100 years of age while the white pine plantations would offset initial losses at 4 years of age and show net gains of approx. 250 Mg C ha^{-1} at 100 years. The GEP growing season length of forest stands increased with increasing age until about 20 years, which coincided with the switch from carbon source to sink. Stand age of white pine plantations did not have an effect on growing season lengths. With the exception of the white pine plantations, peak GEP/ER ratios of the youngest sites tended to occur later in the growing season compared to older sites. Annual ecosystem respiration of the youngest sites in the study was 1.2 to 3.3 times greater than annual photosynthesis (GEP), while the strongest sinks had annual GEP rates that were only 1.2 to 1.9 times greater than ER.

4B10.4 ID:3519 11:30

Interacting effects of increased temperature and lower water table on

ecosystem carbon exchange in a northern Alberta peatland

Lawrence Flanagan
University of Lethbridge
Contact: larry.flanagan@uleth.ca

As part of Fluxnet-Canada and the Canadian Carbon Program, we have been investigating the environmental controls on ecosystem carbon dioxide exchange using the eddy covariance technique in a moderately rich (treed) fen in northern Alberta, Canada. Over a six-year period we have observed significant variation in calculated rates of ecosystem photosynthesis and total ecosystem respiration in association with annual changes in weather. The study period included growing seasons with both cooler and warmer temperatures relative to long-term (30-year) normal conditions. Associated with a directional change to warmer conditions, there was also a trend to lower than normal growing season precipitation, which resulted in a progressive decline of 40 cm in the average water table depth over six years. The shift to warmer and drier conditions stimulated increases in both ecosystem photosynthesis and ecosystem respiration. The ecosystem remained a relatively strong net sink for carbon dioxide during the study period with an average annual rate of net ecosystem production of approximately 150 g C m^{-2} $year^{-1}$. This relatively consistent annual rate of net carbon accumulation measured with eddy covariance was similar to values determined over the last 70 years from measurements made on dated peat cores.

4B10.5 ID:3417 11:45

Fire-driven opening of the closed-canopy black spruce forest as a possible negative feedback to climate change

Pierre Bernier [1], *Raymond Desjardins* [2], *Yi Luo* [3], *Shusen Wang* [4], *Devon Worth* [2], *Yousef Karimi-Zinddashty* [2], *André Beaudoin* [1]
[1] Natural Resources Canada, Canadian Forest Service
[2] Agriculture and Agri-Food Canada, Environmental Health
[3] Environment Canada, Applied Science
[4] Natural Resources Canada, Emergency Management and Environmental Monitoring
Contact: pbernier@rncan.gc.ca

Closed-canopy black spruce forests give way to open lichen spruce woodlands at high latitude in the boreal forest of Eastern Canada. Recent results show a progression over time in the area of lichen woodlands within zones normally dominated by closed canopy forests. This transformation is apparently the result of successive dramatic forest disturbances, in particular forest fires. Climate change is predicted to increase fire frequency in the Eastern boreal forest, with the possibility of increasing the area occupied by lichen woodlands. The contrast between the very pale lichen cover and the very dark black spruce offers a dramatic contrast in reflectance that may compensate for the CO2 emissions from the forest fires. We have therefore looked at the climate change feedback that would result by such change in terms of changes in albedo, stored carbon

and latent heat exchanges. Results to date indicate a strong gradient in albedo with decreasing forest cover. The presentation will compare the total feedback to the climate system in watts per square meters to determine if the increase in fire frequency and the net effect of CO2 emissions from the combustion of the closed black spruce forests and its conversion into lichen woodlands generates a positive or a negative feedback to climate change.

The Laboratory Prospect to the Earth: Advances in Mineral and Rock Physics / Exploration des profondeurs de la Terre : progrès en physique des minéraux et des roches réalisés grâce aux laboratoires

Room / Endroit (Bytowne), Chair / Président (Hans J. Mueller), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B11.1 ID:3668 INVITED/INVITÉ 10:30

Experimental and theoretical studies of the temperature dependence of the magnetic properties of rocks and minerals at in situ reservoir conditions and the implications for predicting other key in situ rock properties

David Potter [1], *Arfan Ali* [2]
[1] University of Alberta
[2] Heriot-Watt University
Contact: dkpotter@ualberta.ca

Magnetic measurements can be used to rapidly and non-destructively provide estimates of other key rock properties, such as mineral content and other geophysical and petrophysical parameters. For instance, our recent work has shown strong correlations between magnetic susceptibility, clay content and permeability. However, very little experimental and theoretical work has been reported on the temperature dependence of magnetic properties at in situ reservoir conditions. The main objective of the present paper was to investigate the magnetic properties (mass magnetization and magnetic susceptibility) of reservoir rocks and minerals with temperature to model downhole in situ conditions. We firstly theoretically modelled the magnetic susceptibility with temperature of some typical reservoir minerals. We then undertook laboratory measurements of magnetic hysteresis at various temperatures on reservoir rocks containing paramagnetic, diamagnetic and ferrimagnetic minerals. Temperature

dependent susceptibility at low field and high field, derived from the hysteresis data, helps one to quantify the content of paramagnetic, diamagnetic and ferrimagnetic minerals in the reservoir rock samples. Finally, we demonstrate how the temperature dependent results need to be taken into account when predicting key petrophysical parameters (such as permeability) from magnetic measurements at in situ reservoir conditions.

4B11.2 ID:3567 INVITED/INVITÉ 11:00

Phase transitions in calcite, dolomite and aragonite

Sytle Antao
University of Calgary
Contact: antao@ucalgary.ca

The phase transitions in calcite, dolomite and aragonite have been recently characterized using Rietveld structure refinements and synchrotron data. In dolomite, the Ca and Mg cation disorder was examined at a fixed pressure of 3 GPa. In calcite and aragonite, their transitions were examined at high temperatures and ambient pressure. In dolomite, the Ca and Mg cations disorder, whereas in calcite the CO3 anion group disorders. The first-order phase transition from aragonite to calcite involves structural readjustment, whereas calcite and dolomite have second-order transitions. These transitions are expected to cause changes in seismic velocities as was observed in GeSe2 glass as well as in magnesioferrite spinel, MgFe2O4. In GeSe2 glass, a change in the rigidity of the glass causes a sharp discontinuity in the S-wave velocity. In magnesioferrite, magnetic disorder causes discontinuities in both the S and P wave, whereas cation relaxation causes the disappearance of the S-wave. Therefore, transitions in minerals have important implications for geophysical models of the Earth's deep interior.

4B11.3 ID:3771 11:15

Conductive heat flow in the core from an experimental perspective

Soushyant Kiarasi , *Rick Secco*
Department of Earth Sciences, University of Western Ontario
Contact: skiarasi@uwo.ca

The thermal regime of the core is controlled by its internal heat production and heat flux to the mantle. Heat flow through the core by conduction is important for inner core growth, overall core cooling, and basal mantle processes. Even the debate on additional heat sources, such as radioactive heating, can be enlightened by a better understanding of core heat flow. The electrical conductivity of the core is known to be a key parameter in the generation of Earth's magnetic field. Knowledge of the electrical conductivity of core materials also provides a means of estimating the thermal conductivity and thus the conductive heat flow in the core by using the Wiedemann-Franz law and the assumption of dominant electronic thermal conduction in metals. Although

geodynamo action could tolerate a factor of 2 difference in the value of electrical conductivity of the core, the same difference could have important consequences for the thermal regime of the core. We report on a series of high pressure experiments designed to measure the electrical conductivities of pure Fe as well as Fe alloys in the solid and liquid states. Employing the four-wire method, electrical resistance measurements at pressures up to 5 GPa in a 200 ton cubic press are made in order to assess the impurity effect on the electrical resistivity of iron under high pressures and temperatures. Resistivity is calculated from resistance measurements using the geometry measurements of each quenched sample under the microscope. Thermal conductivity is derived for the different alloy compositions using a composition-independent Lorenz number.

4B11.4 ID:3690 11:30

Evidence for free oxygen (O^{2-}) in K_2O – SiO_2 glasses from X-ray Photoelectron Spectroscopic (XPS) analysis

Ryan Sawyer , *Wayne Nesbitt* , *Richard Secco*
University of Western Ontario
Contact: rsawyer2@uwo.ca

Knowledge of the structure of silicate melts is fundamental to our understanding of melt properties and behaviour. Silicate glasses are often used as proxies for silicate melts since they can be easily studied with a wide variety of analytical techniques. In this study, X-ray Photoelectron Spectroscopy (XPS) was used to analyze glasses in the K_2O-SiO_2 system of composition xK_2O-$(100-x)SiO_2$ (x = 10, 15, 17, 20, 23, 25, 30, 35 mol%). High resolution spectra of the O 1s orbitals were obtained. The resolution was such that both Bridging Oxygen (BO) and Non-Bridging Oxygen (NBO) atoms could be easily distinguished. Comparisons of BO abundances from XPS analysis to those from stoichiometric calculations revealed a consistent excess in BO atoms. This excess can be explained by a finite equilibrium constant for the reaction: $SiO_2 + 2K_2O \rightarrow K_4SiO_4$. A value of K = 25 was determined through iterative calculations and closely matches the trend in BO abundances observed over the range of compositions studied. Furthermore, the finite nature of the equilibrium constant implies that the stated reaction does not go to completion and that a third type of oxygen atom, free oxygen (O^{2-}), is likely to be present in the glass network. The role that free oxygen atoms may play in the structure of the glass, particularly with respect to possible formation and growth of NBO channels in the network, is not yet clear. Such network modifications could help to relate microscopic glass structure to macroscopic properties such as diffusion or viscosity.

4B11.5 ID:3616 11:45

Elastic and inelastic properties measurements under simulated mantle conditions

Hans J. Mueller [1], *Joern Lauterjung* [1], *Frank R, Schilling* [2], *Christian Lathe* [1], *Michael Wehber* [1]

[1] GFZ German Research Centre for Geosciences
[2] 2Karlsruhe Institute of Technology - University of Karlsruhe
Contact: hjmuel@gfz-potsdam.de

The Earth's deep interior is only accessible by indirect methods, first and foremost seismological studies. The interpretation of these seismic data and the corresponding numerical modelling requires measurements of the elastic properties of representative Earth materials under experimental simulated in-situ pressure-temperature conditions. Various experimental techniques for velocity measurements under experimentally simulated Earth's mantle conditions and the results are described. Large volume presses, also called multi-anvil devices, provide sample volumes 3 to 7 orders of magnitude bigger than diamond anvil cells. They also offer small and even adjustable temperature gradients over the whole sample. The bigger samples make anisotropy and structural effects in complex systems accessible for measurements in principle. The measurement of both elastic wave velocities have also no limits for opaque and encapsulated samples. The ultrasonic interferometry allows the highly precise travel time measurement at a sample enclosed in a high-pressure multi-anvil device. Under high pressure conditions the influence of sample deformation is so important that ultrasonic interferometry requires the exact sample deformation measurement under in situ conditions using synchrotron radiation. Performing measurements with molten samples require encapsulation. We developed a special sample encapsulation for ultrasonic interferometry which do not interfere the acoustic measurements.

Water, weather, and climate serving the energy sector / L'eau, la météo et le climat au service du secteur énergie

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Anne-Marie Valton), Date (04/06/2010), Time / Heure (10:30 - 12:00)

4B14.1 ID:3759 10:30

Wind energy for sites on the Great Lakes

Peter Taylor [1], *Wensong Weng* [2], *Jim Salmon* [3], *Jack Simpson* [4]
[1] York University and Zephyr North Canada
[2] CRESS, York University
[3] Zephyr North Canada
[4] Toronto Hydro Energy Services
Contact: pat@yorku.ca

The wind energy resource offshore is not well understood in the Great Lakes area. This is unfortunate as potential offshore wind farm sites are attracting great interest. In an effort to improve our knowledge of the offshore resource, data are now being collected in specific locations. Unless there happens to be an offshore platform already in place, such as Cleveland's CRIB the cost of installing a platform for a tower or lidar profiler can be significant. Toronto Hydro will soon be installing a lidar anemometer platform in Lake Ontario about 1.2 km offshore from east Toronto and data from that site will be a critical factor in decisions related to a possible wind farm in that area.

Preferred Great Lakes wind farm sites are in relatively shallow water reasonably close to shore. Airflow over these sites will often be within a transition zone as air flows from a rough land surface to a smoother lake surface. There will also often be changes in the thermal stratification of the air column within this Internal Boundary Layer (IBL). For long fetches and heights of order 100m we can formulate and solve the Reynolds averaged Navier-Stokes equations. We make boundary-layer approximations for pressure and assume that along-wind diffusion is minimal. Effects of gentle terrain can be added separately. Results suggest that relatively long fetches of order 100 km are required before winds at 100m fully adjust to the smoother lake surface. Over Lakes Erie and Ontario winds are frequently from the 180-270 degree quadrant and this suggests that the wind resource should be better in the northern (Canadian) half of these lakes. We illustrate this with energy density plots for locations near lakes Erie and Ontario.

4B14.2 ID:3359 10:45

El Niño stills winter winds across the southern Canadian Prairies

Scott St. George , *Stephen Wolfe*
Geological Survey of Canada
Contact: sstgeorg@nrcan.gc.ca

Analysis of long-term terrestrial wind speed (u) records demonstrates that interannual variability is a major component of near-surface wind dynamics in the southern Canadian Prairies (SCP). Since the early 1950s, there have been several periods when negative anomalies in regional u persisted for 8 to 13 consecutive months, with anomalies for individual months exceeding -1 m s-1. Calm conditions on the SCP usually coincided with negative u anomalies across much of western Canada, and nearly all low-wind events occurred during a 'moderate' or 'stronger' El Niño. Wind energy facilities in the SCP have been built during a period of relatively stable wind conditions, and the next El Niño may test their ability to maintain expected energy outputs. El Niño may affect u in other parts of the North American wind corridor and be useful for predicting seasonal or interannual changes in regional wind energy production.

4B14.3 ID:3769 11:00

Mapping Nova Scotia's Wind and Solar Resources

David Colville
AGRG-COGS-NSCC
Contact: David.Colville@nscc.ca

Provincial and municipal governments, policy makers, landowners, and developers as well as companies interested in the production of energy from renewable energy sources can greatly benefit from wind and solar energy resource maps. Such maps have proven useful for planning power system diversification and reliability. The Applied Geomatics Research Group (AGRG) has been engaged in mapping Nova Scotia's renewable energy resources, particularly with respect to the wind and solar resources.

In a partnership between the Université de Moncton and the AGRG, the Nova Scotia Wind Atlas has been developed. The Nova Scotia Department of Energy sponsored this initiative which has resulted in a 200m resolution digital atlas of wind speeds mapped at 30, 50, and 80m heights. This atlas is accessible online for all to see and provides valuable information to those interested in identifying the best locations to install wind turbines or wind farms.

Another partnership, this time between Green Power Labs Inc. and the AGRG, has resulted in a Geographic Information Systems (GIS) based software toolset that calculates and maps the solar energy resource as derived from NASA's 1km resolution Geostationary Operational Environmental Satellite (GOES) images and topographic data. Use of this software results in spatially explicit maps of solar energy resources for a time span of hours to decades. Modeling results are compared to ground-based pyranometer data for validation purposes. While this presentation will focus on results derived for Nova Scotia, the software solution used here could be used to map results for any North American location.

The development methodology and results of these two initiatives will be presented.

4B14.4 ID:3888 11:15

Refinement and validation of a large-eddy simulation method embedded in a mesoscale model

Gasset Nicolas [1], *Benoit Robert* [2], *Masson Christian* [3]
[1] Étudiant au Doctorat à l'École de technologie supérieure
[2] Professeur associé à l'École de technologie supérieure
[3] Professeur à l'École de technologie supérieure
Contact: nicolas.gasset.1@ens.etsmtl.ca

Wind energy applications mainly rely on our abilities to predict and forecast the wind in the ABL over various terrains. However, due to the physical properties of spatial and temporal scales in the atmosphere, surface wind modelling within the horizontal scales of interest for wind technologies (ie from 50 m to 50 km) usually requires the coupling/nesting of two kinds of methods, namely: the microscale/CFD models and the mesoscale models. While common, this coupling/nesting approach is not flexible and requires non trivial adaptations which inevitably introduce limitations, inconsistencies and errors considering the specificities of both families of models. To address this shortcoming, a novel approach based on the integration of a mesoscale and RANS/LES methods is introduced. The starting point is the native physical and dynamical kernel of the Canadian Compressible Community Mesoscale Model (MC2) (Girard et al., 2005) in which are now implemented: (a) new three dimensional turbulence closures (RANS and LES), (b) a new vertical discretization of the physics, (c) a new sounding initialization, and (d) a new dynamical downscaling. As a result, while retaining all the large scale and environmental modelling abilities of the mesoscale model, the method is now able to tackle microscale problems. In order for the new method to be suitable for wind energy applications, the present work concentrates on its validation. As a result, after an introduction of its main features and new abilities, the method is evaluated using a range of standard cases. First, an analytical case (Berger and Grisogono, 1998) is used to evaluate several fundamental key aspects. Then, a series of neutral to stratified ABL are reproduced (Moeng and Sullivan, 1994) based on the various configurations of the method. The findings clearly indicate that the method reproduces satisfactorily the various cases and results are promising.

4B14.5 ID:3993 11:30

Climate diagnostics for future water resources and power generation in watersheds of British Columbia.

Biljana Music [1], *Marco Braun* [1], *Daniel Caya* [1], *Dave Rodenhuis* [2]
[1] Consortium Ouranos
[2] University of Victoria, Pacific Climate Impacts Consortium
Contact: dhuis@uvic.ca

Managers of public power organizations are investigating new methods of alternative energy resources that reduce the carbon footprint and develop renewable, sustainable energy sources. Alternative energy (such as wind, solar, or run-of- river installations) support local energy demands and may deliver transient power into the existing power grid. Hydropower is a renewable energy resource and the backbone (90%) of the power grid in British Columbia (BC), but changes in future climate conditions in this century are expected to change the volume and shift the timing of the water supply on which hydropower depends. In this study, several versions and runs of the Canadian Regional Climate Model (CRCM) coupled to the Canadian Land Surface Scheme (CLASS) were investigated with the A2 emission scenario to diagnose changes in water resources for the upper Columbia basin and the Peace River basins in BC. The results for the 2050s horizon compared to current conditions (1961-1990) show an increase in the annual mean surface temperature of about 2.5°C for both watersheds. This warming is accompanied by a decrease in annual mean snowpack of up to 15%, as well as an increase in precipitation and runoff of about 20%. These changes on the annual timescale have important implications for hydropower generation in addition to seasonal changes. The latter were addressed by using the CRCM simulations to estimate the monthly mean climate change signal of precipitation, evapotranspiration, maximum snow water equivalent and runoff as well as the uncertainty due to the internal variability of the model. Finally, long term climate trends and variability of these hydrologic components are investigated for the designated watersheds over the course of the 21st century. These results provide information for decision makers to manage risks to energy infrastructure and to evaluate the potential of renewable and sustainable energy resources.

4B14.6 ID:3916 **11:45**

Assessment of Canada's hydrokinetic power potential

Wayne Jenkinson [1], *Erika Klyszejko* [2], *Melanie Nadeau* [3]
(Presented by *Robert Wayne Jenkinson*)
[1] National Research Council - Canadian Hydraulics Centre
[2] Environment Canada
[3] CanmetENERGY, Natural Resources Canada
Contact: wayne.jenkinson@nrc.gc.ca

In the current period of climate change and greenhouse gas emission reduction, hydrokinetic, or river current power is emerging as a largely untapped potential source of renewable energy. Additionally hydrokinetic power production uses 'zero head' turbines, which require no dams or barrages and have a small environmental impact. Canada has a vast network of rivers that likely contain significant potential for power production from hydrokinetic sources, although the size of this national resource has never been assessed.

An ongoing, multiphase research project has been initiated by Natural Resources Canada to evaluate techniques for estimating hydrokinetic power on a regional scale and to ultimately characterize and quantify Canada's hydrokinetic resources. The assessment involves a multi-disciplinary approach in watershed characteristics and hydrologic regionalization techniques, including the estimation of flow duration curves (FDCs), and channel geometry, slope, and roughness characteristics at ungauged locations.

The first phase included a methodology and data source review for hydrologic and physiographic regionalization techniques a number of which were short-listed for detailed examination and validation. In the current phase, a number of regionalization techniques are compared in four regions across Canada, evaluated and validated using a jack-knife approach against Environment Canada's velocity and channel geometry measurement databases. Among the methodologies examined are: Canonical Correlation Analysis (CCA) for regionalization of FDC data; the RETScreen FDC estimation methodology; Area-Ratio FDC transposition methodologies; CCA applied channel geometry

regionalization; and geometry extraction from National Hydro Network (NHN) databases.

The next and final phase of this work will involve the application of the best performing regionalization techniques to the national river network to characterize and quantify hydrokinetic power potential across Canada. This project will allow for the tracking of changes in Canada's hydrokinetic resource over time with the acquisition of new data, or through the incorporation of climate change scenarios on streamflow prediction.

Weather and Climate Monitoring in Canada - Current operations and future directions (Part 3)/ Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 3)

Room / Endroit (Ballroom A), Chair / Président (David Bradley), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C01.1 ID:4102 INVITED/INVITÉ 13:30

Measurement of High Latitude Precipitation from Space

Paul Joe [1], *Dave Hudak* [1], *Pavlos Kollias* [2], *Ron Stewart* [3], *Jean-Pierre Blanchet* [4], *Graham Arbery* [5], *Graeme Stephens* [6], *Ralf Bennartz* [7], *Peter Bauer* [8], *Alberto Mugnai* [9], *Jarmo Koistinen* [10], *Chris Derksen* [1]
[1] Environment Canada
[2] McGill University
[3] University of Manitoba
[4] University of Quebec at Montreal
[5] COMDEV
[6] Colorado State University
[7] University of Wisconsin, Madison
[8] ECMWF
[9] Instituto di Scienze dell Atmosfera e del Clima (ISAC)
[10] Finnish Meteorological Institute
Contact: paul.joe@ec.gc.ca

The Arctic is a strategic asset for Canada. In various climate change scenarios with rising temperatures, precipitation is estimated to increase by upwards of 100%. For such a desert-like environment, this has a major environment, social and economic impact from changing transport patterns through the Northwest Passage to human and political activities. Satellite based observations of weather variables, including precipitation, is the only technology that can provide reasonable regional or global coverage. Passive radiometers and active radars are and have been proposed. However, the retrieved estimates are inherently under-constrained and error in precipitation estimates from these sensors must be validated and evaluated. Three approaches to validation are statistical, physical and integrated. The proposed missions are inherently focused on snow and light rainfall. Mountains posed a particular challenge and the recent SNOW-V10 provides an invaluable data set to assess the issues. Requirements for the measurements, the technology and the mission concepts will be described.

4C01.2 ID:3377 INVITED/INVITÉ 13:45

Seamless satellite observation of the Arctic circumpolar region from the Polar Communications and Weather mission

Louis Garand
Environnement Canada
Contact: louis.garand@ec.gc.ca

The Polar Communications and Weather (PCW) mission is defined by a constellation of two satellites in a highly elliptical orbit (HEO, period 12 hours, inclination 63.4 degrees, apogee 39,600 km, perigee near 600 km). PCW will provide seamless observation of the Arctic circumpolar area (refresh time of 15 minutes) from and advanced 20-channel imager with resolution varying from 500 m (VIS) to 2 km (IR) covering the spectral region 0.45 to 14.5 micron. Possibilities are also being evaluated for additional science instruments. By 2016, PCW will have an operational status with meteorological imagery and derived products made available in near real time. The presentation will focus on current and planned activities in preparation for this challenging mission. With PCW, Canada will play a major role in monitoring the Arctic, with applications in weather forecasting, climate and environmental monitoring.

4C01.3 ID:3298 14:00

Radio-Frequency Coordination At Environment Canada – An Overview

Gilles Fournier
Environment Canada
Contact: gilles.fournier@ec.gc.ca

Today, radio-based applications such as remote sensors provide the main source of information about the Earth’s atmosphere and surface. In turn, this information is used for climate, weather and water monitoring, prediction and warnings, natural disasters risk reduction, support of disaster-relief operations and for planning preventive measures for adapting to and mitigating the negative effects of climate change. However Electromagnetic Spectrum is a limited resource and the development of new mass-produced consumer devices and added-value radio applications is putting increased pressure on the frequency bands used for hydrometeorological purposes. Therefore, as recently stressed in statements by WMO, GEO and the AMS, effective and prudent management and coordination of allocated frequency bands is paramount to maintaining and enhancing the quality and accuracy of hydrometeorological operations and research. The implication of Environment Canada to this effort is presented.

4C01.4 ID:4011 14:15

Meteorological Satellite Data Acquisition in Environment Canada

David Bradley , *Mike Manore* , *Arne Alfheim*
Environment Canada
Contact: david.bradley@ec.gc.ca

Environment Canada operates a network of ground stations to acquire satellite data that is broadcast from geostationary and polar-orbiting weather satellites. This satellite data and imagery is used in near-real time by weather and environmental forecasting programs and in numerical weather prediction.

This presentation will provide an overview of the current weather satellite reception infrastructure operated by Environment Canada as well as the future evolution of a coordinated Government of Canada satellite ground segment that will to ensure access to the next generation of satellites that will be launched in the coming years.

4C01.5 ID:3366 14:30

Future Directions of Assimilation of Satellite Observations in the Environment Canada Operational Weather Prediction Systems

Godelieve Deblonde
Environment Canada
Contact: godelieve.deblonde@ec.gc.ca

Numerical weather predictions at Environment Canada are computed with the Global Environmental Multiscale Model (GEM). Satellite observations from operational, demonstration, and research satellites are currently being assimilated in the following operational systems: 1) the GEM Global Deterministic Prediction System, 2) the GEM Global Ensemble Prediction System, and 3) the Regional Deterministic Prediction System. Observations are assimilated in these systems with respectively the following assimilation schemes: 1) a 4D-Var data assimilation system, 2) an Ensemble Kalman Filter, and 3) a 3D-Var data assimilation system. An overview of the upcoming upgrades to these systems, with a particular emphasis on the assimilation of satellite observations, will be provided. As well, a brief summary of plans for a new global sea-ice analysis and land data assimilation system will be presented. Finally, future satellite platforms of importance to short to medium range weather forecasting will be identified.

4C01.6 ID:3828 **14:45**

Study of the Observation Impact on the New Canadian Meso-Strato Global Forecast system

Judy St-James , *Simon Pellerin* , *Monique Tanguay*
Environnement Canada
Contact: Judy.St-James@ec.gc.ca

In June 2009, a new 4D-Var Meso-Strato Global Forecast system was implemented at the Meteorological Service of Canada. Changes include raising the model lid to 0.1 hPa, replacing the vertical coordinate, making use of a new radiative transfer scheme and a non-orographic gravity wave drag scheme. This system also includes additional channels for AMSU-A and higher level GPS-RO observations. This study presents results from an adjoint-based technique (Langland and Baker, 2004) for assessing the value of observations assimilated by 4D-Var algorithms for short-range forecast error in numerical weather prediction. The observation impact (OI) may be partitioned into any subset of observations, instrument type, vertical level, geographic region or any other category. The OI study focuses on the 24 hour forecast error expressed in term of dry total energy norm for the 2006-2007 Winter Season. Three target domains are used: troposphere-globe, troposphere-northern hemisphere and stratosphere-northern hemisphere. Also, the vertical extent of the target domain is separated into the troposphere and stratosphere through a latitude dependant tropopause. Finally, comparisons with a 3D-Var-FGAT Meso-Strato Global Forecast System and with the previous 4D-Var Meso-Global Forecast System are also presented for the same target domains. This diagnostic tool may be used to monitor the quality control and assimilation of observations and also to develop more optimal observing networks.

IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 2) / AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie (Partie 2)

Room / Endroit (Ballroom B), Chair / Président (Zhenxia Long and Will Perrie), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C02.1 ID:3619 **13:30**

Delineation of lakes and channels in the Mackenzie Delta using airborne LIDAR

Neville Crasto [1], *Christopher Hopkinson* [1], *Ian Spooner* [2], *Donald L. Forbes* [3], *Philip Marsh* [4]
[1] Applied Geomatics Research Group
[2] Acadia University
[3] Geological Survey of Canada
[4] Environment Canada
Contact: W0174879@nscc.ca

Airborne scanning laser altimetry or LIDAR can provide valuable perspectives in remote environments due to its ability to cover large areas in less time than alternative survey methods. Within the realm of hydrology, the delineation of channels and lakes followed by an accurate assessment of water levels in deltas are important early steps to subsequent hydrological analysis. This study addresses the suitability of available geomorphometric methods to delineate water bodies in the Mackenzie Delta, NWT. Results will contribute to the development of a hydraulic model for the Mackenzie Delta and studies on subsidence impacts of planned natural gas extraction projects in the area. In addition to prevalent terrain-based methods that use point elevations alone, an approach based on hierarchical multi-criteria classification can exploit commonly unused attributes of LiDAR point data such as scan angle, point density and intensity to identify lakes and channels. Preliminary results suggest that a hierarchical classification approach will yield more accurate delineation results over areas with low to moderate relief than one using elevation based on morphometrics alone. Given the variability of topographic characteristics over the Mackenzie Delta, the final water mask of the study area is expected to be a selective combination of the two methods.

4C02.2 ID:3461 13:45

Mapping the spatial distribution of water levels in the Mackenzie Delta using airborne LiDAR

Chris Hopkinson [1], *Neville Crasto* [2], *Phil Marsh* [3], *Donald L. Forbes* [4]
[1] Applied Geomatics Research Group
[2] Acadia University
[3] Environment Canada
[4] Geological Survey of Canada
Contact: chris.hopkinson@nscc.ca

Airborne LiDAR offers the potential to map channel water levels across wide deltaic floodplains and down the full hydraulic gradient of a channel over short periods of time; a task that would be almost impossible and costly using in situ or field deployed hydrometric methods. An example is presented for the Mackenzie Delta, NWT, where a large hydrologically complex deltaic landscape with hundreds of channels of varying sizes and topology are represented by a sparse hydrometric network. While LiDAR can map terrain surface elevations at high levels of accuracy, water poses a unique challenge for LiDAR due to the specular

reflectance property of the surface, and therefore variations in data density and signal strength across a uniform surface. The first step in this analysis was to conduct an in depth validation of LiDAR water levels at locations with coincident hydrometric data. The second step was to investigate systematic influences to the signal return strength, and quantify any associated systematic variability in water level. The third step was to see if LiDAR could be used to correct the 'assumed' datum elevations of 'floating' hydrometric stations in remote regions of the Delta. The final step was to map and quantity the variation in surface heights across the Delta. It was found that while there were minor systematic variations in water level associated with return signal strength (intensity), water levels could generally be mapped to within 10 cm vertically, or close to the accuracy expected over adjacent land surfaces. Consequently, LiDAR-derived water levels collected over the Mackenzie Delta during August 2008 will provide a spatially explicit but temporally limited validation dataset for hydraulic modelling activities.

4C02.3 ID:3443 14:00

Influence of variable surface air temperature lapse rates on mountain permafrost distribution, Yukon Territory

Antoni Lewkowicz , *Philip Bonnaventure*
University of Ottawa
Contact: alewkowi@uottawa.ca

The spatial and temporal variability of air temperature lapse rates in relation to topography, and their effect on permafrost distribution, were examined for the five widely separated areas in the southern half of the Yukon Territory (60-65°N). In each study area, 10-12 monitoring sites were established, covering a range of elevations, aspects and topographic situations (e.g. ridge crests, valley bottoms, long slopes). Monitoring sites extended from below to above treeline (300-2000 m a.s.l.) and operated from 2006 to 2009, using Onset Hobo Pro loggers (accuracy of ±0.2°C) to measure hourly shielded air temperature. Annual surface air temperature lapse rates are gentle, nonexistent or inverted within the forest zone, whereas they are normal above treeline. They vary seasonally, with normal rates through the summer months and inverted rates in winter. The strength of the inversion and its frequency are lowest in the southern sites and greatest in the north. These characteristics have made empirical-statistical modeling of the spatial distribution of permafrost challenging, as elevational trends that exist above treeline are absent or weak within the forest. The newly-introduced concept of equivalent elevation in which, for example, a site located 500 m below treeline in an area with an inverted lapse rate, has an equivalent elevation above treeline, provides a solution. Its application has allowed statistically significant spatial models to be developed for the study areas that show that the probability of permafrost remains relatively unchanged or actually decreases with elevation through the forest, and only increases above treeline where surface air temperatures rapidly cool. These findings are important for planning future infrastructure development in the discontinuous permafrost of the southern Yukon Territory, as well as for predicting the impact of future climate change on

the terrestrial cryosphere.

4C02.4 ID:3824 14:15

Linear interference and the lead-lag relationship between October Eurasian snow cover anomalies and Arctic wintertime variability

Karen Smith [1], *Paul Kushner* [1], *Judah Cohen* [2]
[1] University of Toronto
[2] Atmospheric and Environmental Research, Inc.
Contact: ksmith@atmosp.physics.utoronto.ca

One of the outstanding questions regarding the observed relationship between October Eurasian snow cover anomalies and the leading mode of Arctic wintertime variability, the Northern Annular Mode (NAM), is what causes the significant lag between the Eurasian snow cover anomalies in October and the associated peak wave activity flux in December. Such a long lag is not observed in general circulation model (GCM) simulations. However, recent work with a comprehensive GCM in which a prescribed autumnal Siberian snow forcing is prescribed suggests a mechanism for the lag in the observational record. It has been shown that, in order to achieve amplification of the wave activity into the stratosphere and a negative zonal mean stratosphere-troposphere NAM response in a GCM, the vertically propagating Rossby wave train generated by the snow forcing must constructively interfere with the background stationary wave. New analysis reveals that the lag in peak wave activity flux can be attributed to unfavorable linear interference conditions between the Rossby wave train associated with the snow cover anomalies and the background stationary wave from October to mid-November. Beginning in mid-November the associated wave train migrates to a position that constructively interferes with the background stationary wave until mid-January. Correspondingly, the associated linear component of the upward wave activity flux increases from approximately zero to become the dominant wave activity flux component over this time period. Further analysis suggests that contructive interference effects are associated not only with stratospheric warming due to Eurasian snow cover anomalies but also are a general feature of troposphere-stratosphere interactions.

4C02.5 ID:3532 14:30

Small scale CO2 and CH4 fluxes in low-arctic (Nunavik, Canada) within summer and winter times

Martin Pilote [1], *Laurier Poisant* [1], *Philippe Constant* [2]
[1] Environment Canada, Science and technology branch
[2] Max Planck Institute for Terrestrial Microbiology, Department of Biogeochemistry
Contact: martin.pilote@ec.gc.ca

The mean global surface temperature is expected to increase in the near future and affect significantly the Arctic and Sub-Arctic ecosystems. This important change will certainly modify the carbon mass balance in Taiga and Tundra

ecosystems. However, it is difficult to predict the exact feedback of greenhouse gases on climate change. Since 2006, gases exchange studies were held in Nunavik in various aquatic and terrestrial ecosystems. In summer, CO2 respiration on top of barren soil and ground vegetation fluctuated between 85.6 and 220.7 mg/m²/h and the mean average at water surface was 44.7 mg/m²/h. At the opposite, CH4 net exchange above aquatic substrate oscillated between 0.04 and 0.36 mg/m²/h and the average on top of barren soil and vegetation was close to zero. In winter time, weak CO2 respiration was measured over snowpack, 0.82 to 16.76 mg/m²/h, and was governed by the height and the physical characteristics of the snow mantle. Further, low CH4 emissions were estimated over snowpack with deposition mostly occurring during day time and evasion during night time. The vicinity of Kuujjuarapik presents a large ecosystemic diversity and the gas exchange processes are site specific. CO2 gas exchange was found to be more related to terrestrial ecosystems and associated to soil substrate, than to ground microbial respiration processes and above ground vegetation communities. On the other hand, CH4 emission was mainly associated with aquatic ecosystems and more subject to fast precipitation change, with an oxic/anoxic transition. In addition, gas exchange during winter time was low but equally. The insulation effect of snowpack on ground temperature and the barrier and/or filter effect of this medium on gas diffusion were significant. Winter time and snowpack coverage might vary substantially in time with climate change and impact the length of the growing season, and thus affect the annual carbon balance.

4C02.6 ID:3523 **14:45**

Climate change factors at Eureka

Glen Lesins , *Tom Duck* , *Jim Drummond*
Dalhousie University
Contact: glen.lesins@dal.ca

In support of the IPY and CANDAC activities, a new analysis of the complete surface and upper air measurements documents the changing climate at Eureka. Consistent surface data are available from 1954, except for water vapour which starts in 1988, and upper air radiosondes from 1961. The annual averaged surface temperature warming of 3.2C since 1972 is dominated by the autumn and winter seasons when the surface based temperature inversion is the strongest. An important contributor to the winter surface warming is the warming above the inversion layer which increases the downward thermal infrared irradiance to the surface. The increased surface radiative forcing caused by the upper air temperature change dominants over the greenhouse gas radiative forcing caused by increases in the local water vapour and carbon dioxide columns. A strong anti-correlation coefficient of -0.61 was found between the winter surface pressure and the North Atlantic Oscillation index. Other findings include a reduction in the frequency of strong anticyclone events in the winter and a reduction in surface wind speeds in the autumn, winter and spring seasons.

Ensemble forecasting: current and emerging applications (Part 2) / Prévisions d'ensemble : applications actuelles et émergentes (Partie 2)

Room / Endroit (Ballroom C), Chair / Président (Bertrand A. Denis), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C03.1 ID:3381 13:30

Ensemble Prediction Systems (EPS) at BC Hydro and their application in hydrometeorological forecasting and weather-related risk management: progress so far and future plans

Timothy Ashman , *Doug Mccollor*
BC Hydro
Contact: timothy.ashman@bchydro.com

BC Hydro is the largest electric utility in western Canada, serving a large majority of British Columbia's population with power generated at over thirty hydroelectric facilities. The watersheds of interest in BC are located in different hydroclimatic regions of the province and range from coastal watersheds driven mostly by fall/winter storm precipitation to interior watersheds driven mostly by meltoff of winter snowpack. The complex terrain in BC provides many challenges in hydrometeorological forecasting. BC Hydro has been developing an ensemble forecasting approach to assist in describing possible weather scenarios to planners and modellers. For short range precipitation forecasts (up to two days), an ensemble of limited-area multi-resolution numerical weather prediction (NWP) products has been developed cooperatively with the University of British Columbia. For medium range forecasts (up to ten days), a suite of precipitation and temperature products from the North American Ensemble Forecast System (NAEFS) has also been developed. The NAEFS products are post-processed specifically for BC Hydro weather observation sites using a running window of daily observed precipitation and temperature from BC Hydro data collection platforms (DCPs) located throughout the watersheds. A review of the current ensemble methodology, energy sector forecasting, future plans (including ensemble streamflow forecasting), and analyses of historic high-impact events will be presented.

4C03.2 ID:3649 13:45

Hydrological test beds for the Canadian global meteorological ensemble prediction system

Juan Alberto Velázquez [1], *François Anctil* [1], *Richard Turcotte* [2], *Vincent Fortin* [3]
[1] Chaire de recherche EDS en prévisions et actions hydrologiques, Université Laval, Québec, Canada.
[2] Centre d'expertise hydrique du Québec, Québec, Canada.
[3] Recherche en prévision numérique environnementale, Environnement Canada, Montréal, Canada.
Contact: juan-alberto.velazquez.1@ulaval.ca

(Special session on Ensemble Forecasting / SCMO-CGU 2010.) Hydrological forecasting consists in the assessment of future streamflow. Current deterministic forecasts do not give any information concerning the uncertainty, which might be limiting in a decision-making process. Ensemble forecasts are expected to fill this gap. In July 2007, the Meteorological Service of Canada has improved its ensemble prediction system, which has been operational since 1998. It uses the GEM model to generate a 20-member ensemble on a 100 km grid, at mid-latitudes. This improved system is used for for hydrological ensemble predictions. Five watersheds in Quebec (Canada) are studied: Chaudière, Châteauguay, Du Nord, Kénogami and Du Lièvre. An interesting 17-day rainfall event has been selected in October 2007. Forecasts are produced in a 3 hours time step for a 3-day forecast horizon. The deterministic forecast is also available and it is compared with the ensemble ones. In order to correct the bias of the ensemble, an updating procedure has been applied to the output data. Results showed that ensemble forecasts are more skilful than the deterministic ones, as measured by the Continuous Ranked Probability Score (CRPS), especially for 72h forecasts. However, the hydrological ensemble forecasts are under dispersed: a situation that improves with the increasing length of the prediction horizons. We conjecture that this is due in part to the fact that uncertainty in the initial conditions of the hydrological model is not taken into account.

4C03.3 ID:3935 14:00

A comparative study of post-processing methods for streamflow ensemble forecasts

Marie-Amélie Boucher [1], *Luc Perreault* [2], *François Anctil* [1]
[1] Université Laval, Chaire de recherche EDS en prévisions et actions hydrologiques.
[2] Institut de Recherche d'Hydro-Québec (IREQ)
Contact: marie-a.boucher.1@ulaval.ca

In this contribution, we present an experiment where we compare various post-processing methods for streamflow ensemble forecasts.

Those methods where originally intended for use with atmospheric forecasts. However, ensemble and probabilistic forecasts are becoming more and more popular in other fields of application, such as streamflow forecasting, as they can potentially provide substantial gains for various applications, such as the

optimization of hydro-power production, for example.

In order for those ensemble forecasts to really fulfill their promises, such as uncertainty assessment, they have to be well calibrated. Even if the atmospheric forecasts are corrected before being provided to the hydrological model, there would still be a need for post-processing because of the bias and errors induced by said model. The question arise concerning the efficiency of existing post-processing methods for hydrological ensemble forecasts. Here we propose to compare five post-processing methods, namely the best member method (Roulston and Smith 2003), its improvement by Wang and Bishop (2005) and subsequently by Fortin and Favre (2007), with Brocker and Smith's method (2007) as well as non-linear Gaussian regression (Gneiting et al. 2005). This comparison will be pursued exploiting three types of data: simple synthetic data for better control on the conditions of the experiment, as well as streamflow ensemble forecasts obtained by neural networks and with HYDROTEL (Fortin et al. 1995), a physics-based hydrological model.

4C03.4 ID:4022 14:15

La prévision à longue échéance au CMC

Juan Sebastian Fontecilla
CMC (Centre météorologique canadien)
Contact: juan-sebastian.fontecilla@ec.gc.ca

Au CMC les prévisions à longue échéance sont produites à l'aide d'un ensemble de quarante membres et quatre modèles numériques. Dans cette présentation nous décrirons cet ensemble et les différents produits déterministes et probabilistes émis par le CMC.

4C03.5 ID:3949 14:30

Post-processing on ensemble systems: when easy means best.

Benoit Archambault [1], *Juan-Sebastian Fontecilla* [1], *Normand Gagnon* [1], *Louis-Philippe Crevier* [1], *Karumuri Ashok* [2], *Doo-Young Lee* [2]
[1] Canadian Meteorological Center
[2] APEC Climate Center
Contact: benoit.archambault@ec.gc.ca

We will describe 2 examples for which the simplest strategy of post-processing of ensemble forecast gives the best results. The first example is the Canadian seasonal forecast system composed of 4 models, two from the Canadian Climate Centre for modelling and analysis and two from the Canadian Meteorological Centre. Issues related to the multi-model approach of this system will be discussed. The second example is the international multi-system initiative for seasonal forecasting known as the Asia-Pacific Economic Cooperation (APEC) Climate Center (APCC). The APEC is a forum for 21 Pacific rim countries or regions including Canada. The APCC provides seasonal forecasts to their regional climate centers with a Multi Model Ensemble (MME) approach. The APCC MME is based on 13 ensemble prediction systems from different institutions including MSC(Canada), NCEP(USA), COLA(USA), KMA(Korea), JMA(Japan), BOM(Australia) and others. In these two examples, we will see that the simple averaging of the members leads to the best results compare with more sophisticated strategy.

4C03.6 ID:3911 **14:45**

Statistical forecast adjustment with seasonally and spatially filtered statistics.

Viatcheslav Kharin
CCCma, Environment Canada, Victoria, B.C.
Contact: slava.kharin@ec.gc.ca

A calibration method of deterministic and probabilistic ensemble seasonal forecasts using seasonally and spatially filtered statistics is presented. The method takes advantage of inter-seasonal and spatial relationships in seasonal statistics to improve sampling properties of estimated adjusting coefficients. It is applied to a 4-model ensemble of seasonal hindcasts from the Canadian Historical Forecast Project for the period of 1969-2002. The new method is shown to be superior to traditional calibration methods in which adjusting coefficients are estimated for each season and each location separately. The reliability and often the resolution of calibrated probability temperature hindcasts over land is improved using the new method. This is an improvement over the previous calibration method which often resulted in degradation of skill over land.

Coastal Oceanography and Inland Waters (Part 2) / Océanographie côtière et les eaux intérieures (Partie 2)

Room / Endroit (Richelieu), Chair / Président (Ram Rao Yerubandi), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C04.1 ID:3837 **INVITED/INVITÉ** **13:30**

Issues in Marine Wastewater Disposal

Philip Roberts
Georgia Institute of Technology
Contact: proberts@ce.gatech.edu

The discharge of domestic wastewaters through outfalls to coastal marine waters is common and probably increasing around the world. It remains controversial, however, and opposition to marine wastewater schemes is common despite extensive experience that shows it to be effective, reliable, and economical with minimal environmental impacts. Considerable controversy also rages with regard to appropriate wastewater treatment levels, with advanced treatment, such as secondary, being often mandated in the US, although it can be shown that lesser levels with an efficient outfall can meet receiving water quality requirements at much lower cost. These water quality issues are primarily related to nutrients, bacteria and pathogens, and toxic materials. At the same time, significant advances have occurred in recent years in all aspects of marine wastewater disposal technology. These include construction methods, particularly in the use of polyethylene pipe and tunneling, oceanographic instrumentation for continuous measurements of currents and density stratification, mathematical modeling of the fate and transport of the discharge, including coastal hydrodynamics and initial mixing processes, and laboratory experiments, including the use of laser-induced fluorescence that have significantly advanced understanding of initial wastewater mixing processes in stratified fluids. The combination of mathematical modeling with measured data has proven particularly fruitful. In this talk, we summarize the present status, particularly their recent advances, in the many aspects of marine wastewater disposal. We address the issues and controversies surrounding it with examples chosen from major marine disposal schemes in existence and proposed around the world in both developed and developing countries.

4C04.2 ID:3926 13:45

Flow acceleration and separation tests for nonlinear models

David Greenberg
DFO Bedford Institute of Oceanography
Contact: greenbergd@mar.dfo-mpo.gc.ca

Strong flows in the Upper Bay of Fundy are now being harnessed for energy extraction using prototype TISEC (Tidal in Stream Energy Conversion) turbines. Accurately simulating the strongly nonlinear flows in such areas is a challenge for shallow water models. To compare the characteristics of different models, we look at a simple configuration - steady flow through a channel with a severe constriction. A steady elevation difference is maintained at the ends of the channel forcing strong flow through the narrows. We compare several models including Fundy, Quoddy, FVCOM, T-UGOm and possibly OPA/NEMO. Cartesian coordinate models are run with zero rotation and spherical models are centered on the equator to eliminate or minimize rotational effects. We look at how flow separation differs in models with different grid structures and parameterization.

4C04.3 ID:3932 14:00

Assessment of tidal current energy in the Minas Passage, Bay of Fundy

Joel Culina [1], *Richard Karsten* [1], *David Greenberg* [2], *Michael Tarbotton* [3]
[1] Acadia University
[2] Bedford Institute of Oceanography
[3] Triton Consultants Ltd.
Contact: joel.culina@acadiau.ca

The strong tidal currents in Minas Passage, connecting Minas Basin to the Bay of Fundy off the north-western coast of Nova Scotia, are a promising source of clean electricity using in-stream turbines. An earlier study by R. Karsten and co-authors demonstrated that 2.5 GW of power can be derived with a maximum of only a 5% change in tidal amplitude at any point in the Bay of Fundy-Gulf of Maine system. Here we expand our study of the Minas Passage by comparing three distinct models of the upper Bay of Fundy using common grids with varying resolutions. The fine-scale, three-dimensional features of the currents and their effect on the greater system suggest that the parameterisation of the effect of turbines as bottom drag need be improved to determine the placement of generators that maximizes power output.

4C04.4 ID:3868 14:15

Estimation of Net Physical Transports and Nutrient Fluxes for a Highly Stratified Coastal Fjord using Box Models: Applied to Rivers Inlet, British Columbia.

Michal Hodal , *Richard Pawlowicz*
University of British Columbia
Contact: mhodal@eos.ubc.ca

In 2008, an extensive two-year field program was launched in Rivers Inlet, BC, with the general objective to understand the food dynamics in the inlet and the long-term objective of studying the collapse of the salmon fishery. Here, we describe the physical controls of the system that govern nutrient fluxes at the base of the food web. We formulate a set of algebraic equations describing mass and tracer balance using a generalization of the classic two layer box model. The relations are used to extract information about the flow from a knowledge of the tracer field. Unlike in most analyses that use salinity alone, in this study we used temperature as an additional tracer to get an independent estimate on flow parameters. In addition, we account for external inputs of water from estimated yields, and atmospheric heat input from meteorological parameters. Finally, we estimate new primary production in the estuary as well as discuss the error associated with our first-order estimates.

4C04.5 ID:3729 14:30

Simulation of temperature and currents in Placentia Bay

Zhimin Ma [1], *Guoqi Han* [2], *Brad De Young* [1], *Mike Foreman* [2]
[1] Memorial University of Newfoundland

[2] Fisheries and Oceans Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

A three-dimensional circulation model is developed to better understand the circulation and physical processes and to help address ecosystem and marine safety issues in Placentia Bay. The model is based on a finite-volume coastal ocean model (FVCOM) with the vertical eddy viscosity calculated from a level 2.5 turbulence closure scheme with 21 unequal vertical levels. The model is forced at the boundaries with 5 tidal constituents and at surface with wind and heat flux. The open boundary temperature and salinity and residual sea level are obtained from a larger-scale shelf model. We examine cases with wind forcing from hourly observations at Argentia and from six-hourly model output. We hindcast temperature and currents for spring 1999. Simulated tidal elevations agree well with tide-gauge data. Model tidal currents have relative errors of 40% compared with observations. The model temperature and non-tidal currents show reasonable agreement with moored measurements.

4C04.6 ID:3859 14:45

Study of Tidal Circulation and Seasonal Variability in the Gulf of Maine and Bay of Fundy using a Nested-Grid Ocean Circulation Model

Daisuke Hasegawa , *Jinyu Sheng*
Department of Oceanography, Dalhousie University
Contact: daisuke@dal.ca

A nested-grid ocean circulation model was developed for the Gulf of Maine and the Bay of Fundy, based on the Princeton Ocean Circulation Model with the wet-and-dry feature. The nested-grid model has two components: a high-resolution (~1.5 km) inner model for the Bay of Fundy and a coarse-resolution (~4.5 km) outer model for the Gulf of Maine and outer Bay of Fundy. A two-way nesting technique is used along the dynamic interface between the outer and inner models. In this study the nested-grid model is used in the investigation of tidal circulation and associated seasonal variability in the Gulf of Maine and Bay of Fundy. Numerical experiments using monthly mean hydrographic climatology and semidiurnal (M2) tidal forcing demonstrate seasonal modifications in phases and amplitudes of tidal currents and surface elevations in the study region. In the upper Bay of Fundy, the summer M2 surface currents and elevations are ~0.1 m/s stronger and ~0.1 m larger respectively than the winter values, and similar but weaker tendencies also appear in the inner Gulf of Maine and in the Georges Bank. The phase differences between the surface and the bottom tidal currents are larger in the summer than these in winter, which indicates the existence of stronger shear due to stronger vertical stratification in the summer months.

Operational sea-ice analysis and prediction (Part 2) / Analyse opérationnelle et prévision des glaces de mer (Partie 2)

Room / Endroit (Frontenac), Chair / Président (Gregory Flato), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C05.1 ID:3902 INVITED/INVITÉ 13:30

U.S. Navy's current and future operational sea-ice analysis and prediction system

Pamela Posey [1], *Richard Allard* [1], *Joseph Metzger* [1], *Alan Wallcraft* [1], *Ole Martin Smedstad* [2], *Michael Phelps* [3]
[1] Naval Research Laboratory, USA
[2] QinetiQ North America, USA
[3] Jacobs Enginerring, USA
Contact: pamela.posey@nrlssc.navy.mil

The Polar Ice Prediction System (PIPS 2.0) is the current U.S. Navy's operational ice forecasting system. PIPS 2.0 forecasts ice conditions in the northern hemisphere with a horizontal grid resolution ranging from 17-33 km depending on the grid location. The system couples the Hibler ice model to the Cox ocean model and exchanges information by interfacing the top level of the ocean model with the ice model. Ice concentration fields derived from the Special Sensor Microwave/Imager (SSM/I) are assimilated into the PIPS 2.0 system along the ice edge. The system produces a 120-hour forecast of ice fields which are sent to the National Ice Center (NIC) to be used in their daily ice forecasts.

More recently, the Naval Research Laboratory (NRL) has performed sea ice hindcasts for the Arctic region derived from the latest coupled ice-ocean prediction system. The 1/12° Arctic Cap Nowcast/Forecast System (ACNFS) is based on the HYbrid Coordinate Ocean Model (HYCOM) coupled to the Los Alamos Community Ice CodE (CICE) and tested using the Navy Coupled Ocean Data Assimilation (NCODA). NCODA uses a three-dimensional variational (3DVAR) data assimilation scheme. The system assimilates surface observations from satellites (altimeter data, sea surface temperature (SST) and sea ice concentration) as well as in-situ SST's and temperature/salinity profiles. The ACNFS has a horizontal resolution ranging from 3.5 km near to pole to approximately 6.5 km near 40°N.

NRL has validated ice drift, ice thickness, ice edge location and ice concentration against unassimilated observation data sets such as Arctic drifting buoy data, ice mass balance buoys, upward looking sonar moorings and ice edge location maps from the NIC. Results from the validation study will include the Canadian

Archipelago and Greenland Sea areas.

4C05.2 ID:3586 14:00

A comparison of two sea ice models: CICE 4 and LIM3

Lynn Pogson
Canadian Ice Service, Environment Canada
Contact: lynn.pogson@mail.mcgill.ca

A new sophisticated sea ice model will be implemented in the different Environment Canada divisions, with the aim to improve sea ice representation in models and increase intra-departmental collaboration. To help select this model, a literature review of two state-of-the-art sea ice models (CICE 4 and LIM3) has been undertaken. The models are evaluated in their abilities to meet the requirements for operational ice forecasting, numerical weather prediction and climate modelling. Overall, CICE 4 offers more flexibility for the different applications than LIM3. In addition, with a more sophisticated radiation scheme and treatment of snow, CICE 4 is the better choice.

4C05.3 ID:3419 14:15

Modelling ocean and sea-ice conditions in the Canadian Arctic Archipelago using a high-resolution nested model within a pan-Arctic model.

Shannon Nudds [1], *Youyu Lu* [1], *Frederic Dupont* [1], *Michael Dunphy* [2], *Charles Hannah* [1], *Simon Prinsenberg* [1]
[1] Bedford Institute of Oceanography
[2] University of Waterloo
Contact: Shannon.Nudds@dfo-mpo.gc.ca

A new ice-ocean model for the Arctic Ocean has been developed based on the Nucleus for European Modelling of the Ocean (NEMO) for purposes of operational and climate research studies. A novel feature of this model is the use of the “two-way nesting” technique using AGRIF (Adaptive Grid Refinement in Fortran) which allows for the embedding of a high-resolution sub-model within a pan-Arctic model to better simulate circulation through the Canadian Arctic Archipelago (CAA). The horizontal resolution is ~18 km for the pan-Arctic domain and ~6 km for the nested region. Initial tests are carried out using climatologies of surface forcing. The simulated seasonal variations of sea-ice, hydrography and ocean circulation are compared with available observations. The model obtains seasonal variations of sea-ice cover and hydrography throughout the pan-Arctic domain consistent with observations, and within the high-resolution domain, the model depicts realistic seasonal cycles of transport and detailed spatial structure of circulation in the CAA. Future work includes simulating variations during 1989-2008 using forcing derived from the new high resolution atmospheric reanalysis of European Centre of Medium Range Weather Forecasting, and validating results with observations.

4C05.4 ID:3606 **14:30**

Offline Ice Forecasting

Christiane Beaudoin
Environnement Canada
Contact: christiane.beaudoin@ec.gc.ca

An ice model is driven directly by atmospheric forecast fields.It produces ice forecasts in an offline mode without having to run an ocean model. The ice model used is the one included in the IML Gulf of St. Lawrence Ocean-Ice Model (Saucier et al. 2004).The GEM 33-km resolution global or 15-km resolution regional forecast fields are used as driving fields. For different months, 120-hour daily ice forecasts were produced on the Polar Canadian Ice Service (CIS) 3d-Var 15-km resolution analysis grid and 24-hour daily ice forecasts were produced on the North American CIS 3d-Var 5-km resolution analysis grid. For the month of March 2007, 24-hour daily ice forecasts were produced over the Great Lakes region on a 5-km resolution grid. Verifications against CIS daily ice charts and comparisons between ice forecasts evolution and 3D-Var ice analyses evolution are shown.

4C05.5 ID:3379 **14:45**

A stochastic model Of ice scouring and grounding

Daniel Godlovitch
University of Victoria
Contact: dgodlovi@uvic.ca

Ice scouring and grounding are phenomena which occur where the water is shallow enough that deep sea-ice ridge keels may make contact with, and ground upon, the sea floor. the study of grounding and scouring rates and intensities hold practical interest for a number of reasons. ice keels scouring the sea floor can damage or destroy pipelines, cables, well-heads, etc. grounded ice tends to facilitate an increase in the population of thick ice around it, which can pose a hazard to structures and vessels. in this study, a numerical model is developed to explore the statistics of grounding and scouring, and the relative importance of the various forcings the ice experiences. in particular, a stochastic model of the dynamic evolution of the sea ice thickness distribution is introduced. two variants of the model are presented: a zero dimensional model and a two dimensional model. the zero dimensional model is useful as a tool to explore the relative sensitivity of the ice population to changes in parameterisation. the two dimensional model adds spatial information including bathymetry. this feature allows the model to be used to study the relative importance of various components of a sea ice model in scouring and grounding problems.

Regional Climate Modelling (Part 4) / Modélisation régionale du climat (Partie 4)

Room / Endroit (Joliet), Chair / Président (Laxmi Sushama), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C06.1 ID:3948 13:30

Simulating Great Lakes water levels with the Canadian Regional Climate Model

Frank Seglenieks , *Murray Mackay*
Environment Canada
Contact: frseglen@uwaterloo.ca

Water levels in the Great Lakes show a large degree of variability due to natural climate variability, anthropogenic climate change, and/or direct human intervention. The attribution of lake level fluctuations to specific causes is not straightforward, though recent record low levels in Lakes Superior and Michigan-Huron have prompted some public outcry for immediate remedial action. Before any such action can be considered, it is essential to develop a deeper understanding of the water balance of the Great Lakes region historically, as well as plausible projections into the coming decades.

Recently the International Joint Commission established a research programme – the International Upper Great Lakes Study – to address the question of changing lake levels and the possibility of modifying the existing regulation plan for Lake Superior outflow. Environment Canada is currently developing a Great Lakes Regional Climate Modelling System to support this study. This model is based on the well established Canadian Regional Climate Model coupled with the latest version of the Canadian Land Surface Scheme, a lake level – river routing scheme, and a thermodynamic lake model. Net basin supply computed using this system is used to drive the Coordinated Great Lakes Routing and Regulation Model (CGLRRM) is order to estimate lake levels. Results for a ten year simulation of current climate will be presented. In addition, use of the model for downscaling GCM based climate projections will also be discussed.

4C06.2 ID:3923 13:45

Using self-organizing maps for the detection of spatial patterns in Canadian RCM climate change projections at the watershed level of Canadian river basins

Marco Braun [1], *Laxmi Sushama* [1], *Daniel Caya* [2]
[1] Université du Québec à Montréal - UQÀM
[2] Consortium Ouranos - Montréal

Contact: Braun.Marco@sca.uqam.ca

Studies of climate change impacts on water resources at the watershed level have shed light on future magnitudes and seasonal shifts of precipitation, runoff, evapotranspiration, soil water content and snow water equivalent. These regional changes are the result of spatial changes in large-scale atmospheric flows of energy and matter that can be realistically reproduced in simulations performed with Regional Climate Models (RCM). An ensemble of Canadian RCM present and future simulations is used to produce monthly average patterns of the components of the water balance of the large Canadian river basins of Yukon, Mackenzie, Columbia, Nelson and St Lawrence. Kohonen neural networks (self-organizing maps) are trained to classify and analyze the large multi-dimensional pattern space obtained from the ensemble. We present the differences in spatial patterns of present and future average monthly precipitation, runoff and snow water equivalent over the five watersheds.

4C06.3 ID:3789 14:00

Canadian RCM Projected Changes to Short and Long-Term Drought Characteristics over the Canadian Prairies

Debasish Paimazumder [1], *Laxmi Sushama* [1], *René Laprise* [1], *Naveed Khaliq* [2], *Dave Sauchyn* [3]
[1] Centre ESCER, Université du Québec à Montréal
[2] Environment Canada
[3] Prairie Adaptation Research Collaborative, University of Regina
Contact: debasish@sca.uqam.ca

This study presents a detailed assessment of projected changes to precipitation and short- and long-term drought characteristics, i.e. severity, frequency and duration, over the Canadian Prairies, using a ten member ensemble of Canadian RCM (CRCM) simulations, of which five correspond to the current climate (1971–2000) and the remaining five are the matching simulations of future climate (2041–2070).

Results suggest a decrease in mean precipitation in summer and an increase for the other seasons while the severity, frequency and maximum duration of both short- and long-term droughts are projected to increase over a large portion of the southern Prairies and along the eastern slope of the Rocky Mountains, with the largest projected changes associated with longer drought events. Classification of the watersheds spanning the southern Prairies based on changes to both severity and frequency further reveal the vulnerability of this region in a changing climate.

4C06.4 ID:3782 14:15

Multisite Simulation of Daily Temperature Extremes: a Comparison between Statistical Downscaling and Regional Climate Models over South-

eastern Canada

Malika Khalili [1], *Van Thanh Van Nguyen* [1], *Philippe Gachon* [2]
[1] McGill University, Department of Civil Engineering and Applied Mechanics
[2] McGill University, Department of Civil Engineering and Applied Mechanics; Environement Canada
Contact: malika.khalili@mail.mcgill.ca

Global Climate Models (GCMs) aim to describe current climate variability and projected climate change at the global and continental scales. However, their coarse resolution is insufficient to accurately reproduce climate conditions at appropriate regional or local scales needed for various types of impact studies. Downscaling techniques are therefore required to provide the necessary high resolution climate information. These techniques are generally divided into statistical and dynamical categories. The statistical downscaling methods are based on the statistical relationships between large-scale atmospheric predictors and local climate predictands. On the other hand, the dynamical downscaling procedures are relied on the high-resolution Regional Climate Models (RCMs) over the area of interest. This study compares the performance of a multi-site statistical downscaling approach and two versions of the Canadian RCM in the downscaling of daily temperature extremes over the south-eastern Canada region. The multi-site statistical downscaling, based on a multiple regression technique, allows the simulation of daily temperature extremes at many sites concurrently. Backward stepwise regression was used to identify significant climate predictors using the National Centre for Environmental Prediction (NCEP) re-analysis data. The two CRCM versions (4.1.1) are driven by both NCEP and the European ERA40 reanalysis products at 45-km of horizontal resolution. Statistical and dynamical downscaling model outputs were compared with observed daily extreme temperature data available at 10 weather stations located in the southwest region of Quebec and southeast region of Ontario for the 1961-1990 period. Results of this comparison have indicated that the multi-site statistical downscaling approach was able to describe accurately various characteristics of daily minimum and maximum temperatures, including their spatial and temporal variation as well as their inter-annual anomalies. In addition, it was found that the multi-site statistical downscaling approach has outperformed the two CRCM runs in terms of accurate reproduction of observed statistics of daily extreme temperatures.

4C06.5 ID:3621 **14:30**

CRCM projected changes to the characteristics of precipitation extremes over Canada

Bratislav Mladjic [1], *Laxmi Sushama* [1], *Naveed Khaliq* [2]
[1] UQAM
[2] Environment Canada, Montreal, Canada
Contact: mladjic@sca.uqam.ca

Changes to the intensity and frequency of hydro-climatic extremes can have

significant impacts on sectors associated with water resources and therefore it is necessary to assess their vulnerabilities in a changing climate. This study focuses on the assessment of projected changes to the frequency and magnitude of extreme precipitation events over Canada using an ensemble of ten 30-year integrations performed with the Canadian Regional Climate Model (CRCM), for reference (1961–1990) and future (2040–2071) periods; the future simulations correspond to A2 SRES scenario. Two methods, the regional frequency analysis (RFA), which operates at the scale of statistically homogenous units of pre-defined climatic regions, with the possibility of downscaling to grid-cell level, and the individual grid-box analysis (GBA) are used in this study, with the time-slice stationarity assumption. Validation of model simulated 20-, 50- and 100-year return levels of 1-, 2-, 3-, 5-, 7- and 10-day precipitation events against those observed for the 1961–1990 period using both the RFA and GBA methods will be presented. Changes to the intensity and duration of multi-day precipitation extremes over Canada are also assessed using regional frequency analysis (RFA) and individual grid- box analysis (GBA) and these results will also be presented. An estimate of uncertainty in the regional growth curves for each of the five pairs of reference and future period simulations is carried out using the nonparametric vector bootstrap resampling method and expressed in the form of a confidence interval for any return level. The results of the study have strong implications for both design and management of water resource related projects and for assessing sustainability of existing infrastructures in a changing climate.

Storm Studies in the Arctic (STAR) (Part 1) / Programme Storm Studies in the Arctic (STAR) (Partie 1)

Room / Endroit (Chaudière), Chair / Président (Ron Stewart), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C07.1 ID:3356 **13:30**

Storm Studies in the Arctic (STAR): An Overview

John Hanesiak [1], *Ron Stewart* [1], *David Barber* [1], *Dylan Jones* [2], *Gordon Mcbean* [3], *Peter Taylor* [4], *Walter Strapp* [5], *Mengistu Wolde* [6]
[1] University of Manitoba
[2] University of Toronto
[3] University of Western Ontario
[4] York University
[5] Environment Canada
[6] National Research Council

Contact: john_hanesiak@umanitoba.ca

The Storm Studies in the Arctic (STAR) is a four year CFCAS funded research Network (2007-2010) that is in its final year of scientific activities. Much has been learned. STAR conducted a major meteorological field project between October 10 – November 30, 2007 and in February 2008, focused on southern Baffin Island, Nunavut, Canada, a region that experiences intense autumn and winter storms. The project has concentrated on documenting, better understanding and contributing to improved prediction of meteorological and related hazards in the Arctic including their modification by local topography and land-sea-ice-ocean transitions, and their impact on local communities. STAR also has a significant outreach component including the production of educational material for the northern grade-12 curriculum of Nunavut. STAR has produced a variety of surface-based and unique research aircraft field measurements, high-resolution modeling products/experiments and remote sensing measurements (including CloudSat) as part of its science strategy, and has the first Arctic CloudSat validation data set. A number of synoptic and mesoscale features were sampled such as fronts, upslope/terrain-enhanced precipitation, convective precipitation, boundary layer cloud/precipitation as well as targeted CloudSat missions. The talk will highlight recent scientific findings, community interaction studies and outreach activities.

4C07.2 ID:4141 13:45

Measurements of Drifting and Blowing Snow at Iqaluit, Nunavut, Canada during the STAR Project

Mark Gordon [1], *Sumita Biswas* [2], *Peter Taylor* [2], *John Hanesiak* [3], *Marna Albarran-Melzer* [2], *Shannon Fargey* [3]
[1] Environment Canada
[2] York University
[3] University of Manitoba
Contact: pat@yorku.ca

A 10 m meteorological tower near Iqaluit Airport was operational from late October 2007 to early April 2008. Measurements included wind speed, temperature, pressure, humidity, visibility, and blowing snow number flux. Number flux measurements give a frequency of blowing and drifting snow of approximately 10% for the duration of the study, while meteorological observations from the Iqaluit weather office give a frequency of approximately 5%. Winter winds were predominantly from the northwest, and some strong southeasterly winds were also observed, especially in early spring. The average roughness length determined from the variance of wind speed is $z0 = 0.14$ mm. Threshold wind speeds for the onset of blowing snow ranged from 7 m/s to 12 m/s, excluding events with falling snow. Measurements of visibility correlate well with the measured number density ($R2 = 0.83$), assuming a constant particle diameter of $d \approx 100$ μm at a height of 2 m. A camera system was used during blowing snow events in February to measure the size of blowing snow particles

and the mass flux of blowing snow. At a height of 0.35 m, the particle size distribution can be approximated by a gamma distribution with shape parameter $4.4 < \alpha < 6.4$ and an average particle diameter of $70 < d < 148$ μm. The particle size at a height of 0.35 m increases linearly with the 10 m wind speed (R2 = 0.69). Mass flux measurements demonstrate a power law relation with height between 0.1 and 0.9 m, with a negative exponent of approximately 2.5. Blowing snow density follows a power law relation with height between 0.85 and 1.85 m, with a negative exponent of approximately 1.3.

4C07.3 ID:4142 14:00

Mesonet measurements in the area around Iqaluit, Nunavut, Canada during the winter 2007/2008 STAR Project

Marna Albarran-Melzer [1], *Mark Gordon* [2], *Sumita Biswas* [1], *Peter Taylor* [1], *John Hanesiak* [3], *Shannon Fargey* [3]
[1] York University
[2] Environment Canada
[3] University of Manitoba
Contact: pat@yorku.ca

During the STAR (Storm Studies in the Arctic) project 10 surface mesonet weather stations were deployed by helicopter in an area around Iqaluit, Nunavut in September 2007. Four of the stations were equipped with satellite phones to allow daily data transfer to a base station while data from other stations were retrieved when those stations were removed in April 2008. Performance and reliability of the network in the harsh winter conditions will be reviewed. Statistics of the mesonet plus upper air wind direction and other data illustrate the topographic channeling of flow in NW-SE directions along the axis of Frobisher Bay and the Sylvia Grinnell River valley. Pressure, temperature and humidity data will also be presented

4C07.4 ID:3980 14:15

Analysis of strong wind events in Iqaluit, NU using observations and high-resolution modeling

Rebekah Martin [1], *John Hanesiak* [1], *Ayrton Zadra* [2], *Ron Goodson* [2]
[1] University of Manitoba
[2] Environment Canada
Contact: martinr0@cc.umanitoba.ca

While north easterly winds at Iqaluit are rare, as a result of topographic effects they are generally high, and their successful forecasting and modelling can be difficult as a result of surface interaction sensitivities. For the past several seasons, the GEM LAM 2.5 has been run over Baffin Island operationally. An analysis of the model output over this time period has indicated that strong north easterly winds at Iqaluit are more often missed by the model either in wind direction or strength as well as the timing. In addition, although synoptic settings

appear similar for many events, strong winds manifest themselves at the surface in some events and not in others.

In this talk, we will review the dynamics of the orographic interaction that lead to strong north easterly wind events in the Iqaluit area. Comparisons of several events are studied in detail to assess how and why strong winds can occur in this regions of the Arctic using observations and GEM LAM simulations.

4C07.5 ID:4055 14:30

Structure of an Extra Tropical Cyclone in the Arctic

William Henson [1], *Ronald Stewart* [2], *David Hudak* [3], *Mengistu Wolde* [4]
[1] Dept. of Atmospheric Sciences, McGill University
[2] University of Manitoba
[3] Environment Canada
[4] National Research Council
Contact: william.henson@gmail.com

During the period 16 to 20 November 2007 an extratropical cyclone moved north over Quebec and onto Baffin Island. Several airports in the region, including those at Iqaluit and Kuujjuaq, were closed. This system then tracked north/north-west over Baffin Island into Foxe Basin. It continued to deepen until it reached a pressure of at least 964 mb after which it started to dissipate. This storm system was observed with several observational platforms, including an X band radar in Iqaluit, the NRC Convair 580 and CloudSat, as part of the Storm Studies in the Arctic (STAR) project. This event was associated with a number of features including a band of freezing precipitation, a pronounced 'eye', strong near-surface wind shear, and multi-layered cloud fields. These are other features of the storm system will be discussed.

Carbon Cycling of Canadian Forests and Peatlands (Part 2) / Cycle du carbone des forêts et tourbières canadiennes (Partie 2)

Room / Endroit (Capitale), Chair / Président (J.H. McCaughey), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C08.1 ID:4057 13:30

Quantifying the response of forest carbon exchanges to soil water deficit across an age-sequence of temperate white pine forests.

Jason Brodeur [1], *M. Altaf Arain* [1], *Matthias Peichl* [2], *Samantha Mackay* [1], *Emily*

Nicholas [1]
[1] McMaster University
[2] University College Cork, Cork, UK
Contact: brodeujj@mcmaster.ca

The widespread implementation of continuous eddy flux and meteorological measurement systems has enhanced examination of connections between carbon and water cycles over many different ecosystems at inter-annual to decadal time scales. This study examines the influence of soil water availability on components of net ecosystem CO_2 exchange at varying time scales for planted temperate white pine forests at different stages of growth, in southern Ontario, Canada. Seven years (2003--2009) of eddy flux, meteorological and edaphic data were analyzed from three even-aged sites (71, 36 and 8 years old) to establish the influence of effective soil water deficit on gross ecosystem photosynthesis (GEP) and ecosystem respiration (RE). A soil-moisture crossing statistic approach was used to quantify the point-to-point and cumulative severity of soil water deficit at different depths in the soil column. Short-term anomalies in GEP and RE were identified through use of separate statistical models, where flux and meteorological data were assimilated to provide a comparison between fluxes measured during soil water stress conditions and modeled estimates of such fluxes without the presence of soil water stress. Compiled results showed a moderate and comparable suppression of both GEP and RE with increasing soil water deficits below selected thresholds across all years and sites. Within this trend, however, substantial discrepancies in this relationship were found on inter-site and inter-year scales of comparison, suggesting differing water-use strategies among forest ages, and increasing access to, and importance of deep soil-water availability with increasing stand age. A comparison of two anomalously dry growing seasons (2005, 2007) at the 71-year-old site further highlights the critical role of deep-soil water to this stand, as well as lagged effects of previous years' soil water status on the carbon exchanges of these forests.

4C08.2 ID:3790 13:45

CO_2 fluxes of an Eastern Canadian boreal black spruce chronosequence

Jean-Lionel Payeur-Poirier , *Carole Coursolle* , *Hank Margolis* , *Marc-André Giasson*
Université Laval, Centre d'étude de la forêt (CEF)
Contact: jean-lionel.payeur-poirier.1@ulaval.ca

The carbon sink or source status of a forest varies according to climatic conditions, but is mainly dominated by the effects of stand development. CO_2 fluxes of a chronosequence of managed black spruce stands (8, 33 and 100 years old) located in the boreal forest of Québec were measured over a one-year period at the ecosystem scale with the eddy covariance technique and for soils with a portable infrared gas analyzer. On an annual basis, the young site was a carbon source (-83 g C m^{-2} yr^{-1}), the juvenile site a moderate sink (143 g C m^{-2} yr^{-}

^{1}) and the mature site a small sink (6 g C m^{-2} yr^{-1}). The ratio of soil respiration (R_{SOIL}) to ecosystem respiration (R_{ECO}) for the snow-free period was much lower for the juvenile site than for the other two sites. Intra-site differences in base respiration ($R10_{SOIL}$) values were only present at the young and mature sites while $Q10_{SOIL}$ values (the multiplying factor of R_{SOIL} per 10 ºC increase) differed only between sites. These results suggest that the carbon cycle of boreal stands after harvest is affected by stand development and that differences in the ratio of R_{SOIL} to R_{ECO} is a key factor in the passage from carbon source to sink of boreal stands. No significant effects of soil water content or seasonality on R_{SOIL} rates were detected.

4C08.3 ID:3746 14:00

A study evaluating the consequences of reduced precipitation input on transpiration and growth rates in a temperate pine ecosystem

Samantha L. Mackay , *M. Altaf Arain* , *Jason J. Brodeur* , *Emily Nicholas*
(Presented by *Samantha Mackay*)
McMaster University
Contact: mackays@mcmaster.ca

A study evaluating the response of canopy transpiration (Ec) and growth rates to reduced water input, was conducted in a managed 70-year old planted temperate white pine (Pinus strobus L.) forest, in Southern Ontario from January to December 2009. In order to induce the drought, a 20 m x 20 m throughfall exclusion setup was established using interlocking aluminum troughs at a 3-inch slope. Throughfall was excluded from April 1st until July 3rd. During this period, 270 mm of rainfall occurred (27% of annual precipitation) of which 90% was excluded. Sapflow velocity, soil moisture and soil temperature (at multiple depths) were measured continuously in both reference and drought plots. Dendrometer bands were also installed on all instrumented trees. The study was carried out at the Fluxnet-Canada TP39 site. Prior to enforced drought, adjacent plots showed slight variability in soil moisture ($p < 0.05$) while tree diameter and soil temperature did not show significant variability ($p > 0.05$). Daily values of Ec from each plot ranged from 0 to 1.6 mm d^{-1} over the growing season (March-November). The impact of the rainfall exclusion did not affect Ec until early June, 60 days after the drought was in place. Normalized values of Ec showed a 30% decrease from the drought trees compared to the reference. Cumulative growth rates between the two plots showed a net decrease in the drought trees of 48% from the reference and earlier termination of growth. Currently, the effects of early growing season extreme drought events on carbon and water balances in conifer forests are poorly understood. The findings of this study help to establish the impacts of early growing season droughts on these forest ecosystems and evaluate the potential response under future predicted climate regimes.

4C08.4 ID:3514 14:15

DigiBog: A New Model Framework for Simulating and Visualising the

Spatial and Temporal Development of Carbon Stocks in Northern Peat Soils

Paul Morris [1], *Andy Baird* [2], *Lisa Belyea* [3], *Mike Waddington* [1]
[1] McMaster Centre for Climate Change, McMaster University
[2] School of Geography, University of Leeds
[3] Department of Geography, Queen Mary University of London
Contact: pmorris@mcmaster.ca

The deep, carbon-rich peat deposits of the northern hemisphere consist of plant detritus, preserved by a combination of cold, waterlogged soil conditions, and the inherent recalcitrance of some peatland plant carbohydrates. These soils represent highly concentrated, globally significant terrestrial sinks for atmospheric carbon. Recent modelling studies suggest that these carbon stocks may be fragile ones, likely to oxidise under warming, drying climates, thereby exaggerating the global warming effect. However, existing models of peatland development commonly neglect important ecohydrological feedbacks, or ignore internal spatial structure, meaning that their findings of peatland fragility may rely on unrealistic assumptions. Particularly, circular feedbacks between water-table behaviour, plant productivity, peat decay and peat permeability may add self-regulation, and so resistance, to peatlands. We present DigiBog, a new model of peatland development in three dimensions using a fine (cm) spatial scale, allowing the novel representation of realistic feedbacks. Furthermore, Digibog allows powerful visualisation of the spatial and temporal dynamics of peat soil development, showing profile (2-D) changes in peatland properties and internal structure. Incremental increases in model complexity, through the increasingly realistic representation of ecohydrological feedbacks, lead to model behaviour which is initially simple and precipitation driven (when no ecohydrological feedbacks are considered), then bistable (intermediate model complexity), and finally self-regulatory and partly resistant to climatic influences (multiple feedbacks considered). Feedbacks between multiple ecohydrological processes in space and time may cause peatlands to be more resistant to climatic forcing than previously believed. We conclude that models which seek to predict the response of peatland carbon stocks to climatic change cannot do so accurately without a consideration of the feedbacks between ecological and hydrological processes that we advocate. Nonetheless, our conceptual model is likely still incomplete, and additional feedbacks which operate in real peatlands, not yet considered in DigiBog, may cause further qualitative alterations to model behaviour.

4C08.5 ID:3594 14:30

Characterisation of peat structure using X-ray computed tomography

Nicholas Kettridge , *Andrew Binley*
Lancaster Environment Centre, Lancaster University
Contact: n.kettridge@lancaster.ac.uk

Models that aim to simulate the formation and development of northern peatlands require a quantitative representation of how the hydrological, thermal and

biogeochemical conditions modify the properties of a parcel of vegetation/peat as it is encompassed within a peatland as the peatland grows. Characterisation of these ecohydrological relationships requires an understanding of how the peat physical properties emerge from the constituents which are contained within the parcel of peat. These ecohydrological relationships vary in their level of complexity. Physical properties such as the porosity and volumetric heat capacity depend simply on the volume of the constituents within the parcel of peat. In comparison, properties including the hydraulic conductivity, thermal conductivity, and potentially the peat compressibility and the ability of the peat to trap biogenic gas, depend not only on the volume of these constituents, but also on their spatial arrangement within the parcel. We build on previous work to develop a method for visualising the 3-D structure of peat using X-ray CT. This X-ray CT approach is subsequently applied to a range of peat types at different levels of decomposition. The X-ray CT images are quantitatively analysed to obtain detailed metrics that represent both the composition and structural arrangement of the peat constituents. These metrics are interpreted to identify how the structural properties of the peat vary both within (at different levels of decomposition) and between different peat types. The peat metrics are compared with more readily available, more widely applied, measures of the peat composition (Von Post, bulk density, porosity) to identify whether the X-ray CT approach is differentiating between previously unidentifiable characteristics of the peat, or whether these structural characteristics are strongly correlated to the peat composition.

4C08.6 ID:3605 **14:45**

Subsurface patterning in peat physical properties identified from geophysical methods

Nicholas Kettridge [1], *Xavier Comas* [2], *Andrew Binley* [1], *Nigel Cassidy* [3], *Jan Van Der Kruk* [4], *Mike Waddington* [5]

[1] Lancaster Environment Centre, Lancaster University
[2] Department of Geosciences, Florida Atlantic University
[3] Department of Earth Sciences and Geography, Keele University
[4] Forschungszentrum Juelich
[5] School of Geography and Earth Sciences, McMaster University
Contact: n.kettridge@lancaster.ac.uk

Northern peatlands are characterised by surface patterning of hummocks, lawns, hollows and pools. This surface patterning strongly influences the carbon dynamics, hydrology and thermal behaviour of these environments. However, the resilience and mobility of these surface micro habitats during the development of a peatland, and under future climatic conditions, is currently uncertain. Subsurface peat properties are traditionally identified from isolated cores taken across the peat surface. Such coring techniques enable changes in the peat properties through the 1-D profile to be identified. However, placing these 1-D changes into the context of the 3-D functioning of a patterned peatland can prove problematic. For example, a shift in the vegetation composition may result either

from the movement of micro habitats across the peatland or from peatland wide shifts in the vegetation cover. In comparison, geophysical techniques enable the continuous/semi-continuous measurement of the peat physical properties enabling a spatially explicit understanding of how these properties vary through a peat profile. We apply geophysical methods (ground-penetrating radar, electrical imaging) to map the subsurface structures in a patterned peatland. We identify zones of continuity that suggest resilience in the location of some larger hummock features. We also identify a pattern of dipping layers through the profile that suggest a continuous movement of surrounding micro habitats across large areas of the peatland during the course of its development. We focus our measurements on selected hummock and hollow features and obtain vertical profiles of the dielectric permittivity and electrical resistivity. These measurements highlight the continuous small scale (10^{-1}m) alternating characteristics of the peat properties through the profiles that may be associated with the mobility of the peat micro habitats. In addition, there is also evidence of a large scale (10^{0}m) fluctuation in the peat properties through the profiles that could potentially be associated with peatland-wide variations in vegetation/climatic conditions.

Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 3) / Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 3)

Room / Endroit (Panorama), Chair / Président (John Pomeroy), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C09.1 ID:3866 **13:30**

Improved representation of the snowmelt runoff contributing area and streamflow in a small alpine basin

Chris Debeer , *John Pomeroy*
University of Saskatchewan

Contact: cmd225@mail.usask.ca

Realistic simulation of snowmelt runoff in cold regions alpine basins requires adequate representation of the spatial variability of snow water equivalent (SWE), snowmelt energetics, and areal snow-cover depletion. Much of this variability can be resolved by applying physically based point scale melt rate computations to distributions of SWE over distinct slope- and aspect-based terrain units. Differences in melt timing and rates also arise at smaller spatial scales due to differences in the internal energy content and warming of cold, redistributed snow-covers. This can be accounted for by computing melt rates separately for different SWE depths within the distributions on each slope. We used this modelling framework to simulate the snow-cover depletion and meltwater generation over a small alpine basin in the Canadian Rocky Mountains. Slope-based melt rates were computed using an energy balance snowmelt routine (Snobal) within the Cold Regions Hydrological Model (CRHM) platform, and applied to measured SWE distributions over the different slopes. The snowmelt runoff contributing area (SRCA) was characterized as the product of the snow-covered area and the fraction of each distribution that was actively melting. Results from each slope unit were then aggregated over the basin to simulate the magnitude and timing of meltwater generation. These inputs were routed through the basin using a conceptual lag and route approach to derive the snowmelt hydrograph at the basin outlet. The results showed that accounting for the spatial variability of snowmelt dynamics over the landscape in this manner produced a significant improvement in the simulated hydrograph compared to simulations based on spatially uniform snowmelt.

4C09.2 ID:3829 **13:45**

Laboratory simulation of water and heat transport in sub- arctic peat soils: Experimental setup

Ranjeet M. Nagare [1], *Robert Schincariol* [1], *William Quinton* [2], *Masaki Hayashi* [3]
(Presented by *Ranjeet Nagare*)
[1] The University of Western Ontario, Dept. Earth Sciences
[2] Wilfrid Laurier University, Dept. Geography and Env. Studies
[3] University of Calgary, Dept. Geology and Geophysics
Contact: rnagare@uwo.ca

It is difficult to maintain one-dimensional temperature gradients in laboratory experiments due to radial temperature distributions in response to surrounding temperature interference. We have constructed a two level walk-in climate simulation laboratory with controlled sunlight, precipitation, humidity and air temperature with a goal of studying the closely linked water and heat transport processes in controlled laboratory setting. This paper describes the experimental setup for one dimensional freeze- thaw experiments on four 56 cm diameter and 120 cm deep peat columns excised from the sub-arctic soil and transported intact in temperature controlled condition to the laboratory. The columns are populated with soil temperature and moisture sensors. We are able to setup and maintain a

40 cm thick frozen layer, which represents permafrost, below the overlying peat layer representing active layer. Column end boundary temperatures are controlled by contact with air maintained at constant temperatures. Lateral heat transfer is minimized with neoprene foam liner inside of the sample containers in conjunction with an outer insulation. Evaluation based on studies of the propagation of the freezing front suggests that the desired one-dimensional temperature gradient is maintained throughout the column during freeze-thaw cycles. Experiments are underway for investigations into fundamentals of coupled heat and water transport and gas flux in peat during freeze-thaw regimes.

4C09.3 ID:3610 14:00

Impacts of groundwater flow on permafrost degradation

Isabelle De Grandpré , *Daniel Fortier*
Département de Géographie, Université de Montréal
Contact: isabelle.de.grandpre@umontreal.ca

Permafrost warming has been affecting the North West portion of North America for a few decades now. This warming alters the thermal state of the permafrost and promotes permafrost degradation (increase in active layer depth, acceleration of thermokarst process and development of taliks (unfrozen zones)). The results are permafrost thawing and soil subsidence. Several processes of permafrost degradation have been studied; however, the impact of groundwater flow on permafrost degradation remains poorly knows. Field observations revealed that soil subsidence can be important at the location of preferential groundwater flow. We report groundwater flow under a road embankment and road subsidence along a segment of the Alaska Highway near Beaver Creek (Yukon). We designed a methodology to measure groundwater flow and water temperature crossing under the road by using a network of piezometers, some equipped with temperature and pressure sensors. The microtopography of the site was surveyed to determine the local hydraulic gradient. The stratigraphy of the site comprises a layer of organic material over several meters of sandy silt. In response to permafrost degradation and thaw-settlement since the construction of the road, the embankment has subsided a few meters in the ground and the coarse gravelly embankment material now intersects the natural groundwater flow paths. It is suggested that groundwater flows along preferential paths essentially located within thawed, high hydraulic conductivity, embankment material. Water flow through the underlying thawed sandy silt is presumably much slower. Measurements of water temperature indicate that water is progressively loosing heat as it flows under the road. We propose that this energy transfer to the surrounding ground contributes to the degradation of the underlying permafrost through various processes of convective and conductive heat transfer. For this reason groundwater flow should be taken into account in permafrost degradation models and scenarios.

4C09.4 ID:3918 14:15

Simulating groundwater flow in cold regions with dynamic freeze-thaw

Jeffrey Mckenzie [1], *Clifford Voss* [2], *Michelle Walvoord* [2]
[1] McGill University
[2] US Geological Survey
Contact: mckenzie@eps.mcgill.ca

Rapid warming of continuous and discontinuous permafrost regions is changing cold regions hydrology, but the effect of these changes on groundwater hydrology is complex and difficult to observe and quantify. Subsurface freezing and thawing involves complex feedbacks between the coupled subsurface ice and groundwater flow systems. Numerical groundwater simulation allows elucidation of some of these processes. Two approaches are presented. In the first approach, a new coupled groundwater-energy-transport model, SUTRA-ICE, based on SUTRA, a U.S. Geological Survey (USGS) model for coupled groundwater flow and heat transport, simulates freezing and melting of groundwater. It includes proportional heat capacity and thermal conductivity of water and ice, decreasing matrix permeability due to ice formation, and latent heat. The model was verified by correctly simulating an analytical solution for ice formation in a porous medium with a mixed ice-water zone. Two- and three-dimensional hillslope benchmark problems, developed for model inter-comparison, also demonstrate the potential for freezing and thawing to dramatically alter the groundwater flow regime. An example using SUTRA-ICE demonstrates how 'winter' freezing effectively isolates the regional groundwater system from surface recharge, causing seasonal horizontal flow reversals. A second approach, using the USGS MODFLOW groundwater simulator, demonstrates the influence of permafrost distribution on regional hydrology in the Yukon Flats Basin of Alaska. This approach employs time-varying low permeability zones to represent frozen regions. Simulating various stages of permafrost expansion and thaw shows that the existence of permafrost exerts a significant control on regional recharge and discharge patterns. The results underpin expectations of significant impacts on groundwater flow systems of potential future climate warming and permafrost thaw.

4C09.5 ID:3876 14:30

The Impacts of Forest Harvesting on Evapotranspiration from a Western Boreal Plain aspen forest

Scott Brown [1], *Richard Petrone* [1], *Dr. Kevin Devito* [2]
[1] Cold Regions Research Centre, Wilfrid Laurier University, Waterloo, Ontario, Canada
[2] Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada
Contact: scbrown@wlu.ca

The Western Boreal Plain (WBP) of North Central Alberta consists of a mosaic of wetlands and aspen *(Populus tremuloides)* dominated uplands. This region operates within a moisture deficit regime where precipitation (P) and evapotranspiration (ET) are the dominant hydrologic fluxes. Significant industrial

pressure in the WBP from forestry practices coupled with expanding oil and gas development will impact the forest vegetation distribution and hydrologic recovery of the region. In order to quantify the impacts of forest harvesting on water cycling, ET was characterized using the eddy covariance (EC) technique at multiple locations within a staggered harvest from 2005 to 2009 during the growing seasons. For natural, pre-disturbance conditions aspen forest ET was controlled primarily through atmospheric demand (VPD) with an influence on rooting zone soil moisture (θ). During peak growth periods forest ET averaged 3.5 mm/d in 2005 and 2006. A winter harvest on the south facing slope (SFS) aspen forest was conducted in 2007 which lead to a reduction in ET compared to pre-disturbance conditions. The initial removal of the aspen forest and shrub understory resulted in a peak growth ET rate of 2.8 mm/d while ET from the undisturbed north facing slope (NFS) aspen forest averaged 3.4 mm/d. Slight increases in soil evaporation (E_S) were observed as the removal of the canopy resulted in increased θ and available energy reaching the soil surface. Consequently, the NFS aspen forest was harvested in the winter of 2008 resulting in a reduction in ET similar to that of the SFS with peak growth season ET rates of 2.6 mm/d. The SFS saw an increase in ET to 3.0 mm/d in 2008, a result of rapid sapling regeneration and subsequent increases in transpiration. The dense post-harvest regeneration has shown to have the most significant control on ET during the early stages of recovery. The resulting increases in leaf area index (LAI) ultimately control the amount of precipitation that reaches the forest floor thus controlling the θ availability in the rooting zone.

4C09.6 ID:3667 14:45

Sensitivity of potential evapotranspiration to canopy characteristics within the Western Boreal Forest, Alberta

Laura Chasmer [1], *Richard Petrone* [1], *Kevin Devito* [2], *Carl Mendoza* [3], *William Quinton* [1]
[1] Cold Regions Research Centre, Dept. of Geography
[2] Department of Biological Sciences, University of Alberta
[3] Department of Earth and Atmospheric Sciences, University of Alberta
Contact: lechasme@yahoo.ca

The climatology of the Western Boreal Forest (WBF) of northern Alberta is characterized by prolonged periods of drought with infrequent wet years. During most years, potential evapotranspiration (PET) exceeds precipitation (P). Therefore, future changes in climate, especially P will likely alter actual evapotranspiration (AET) within this complex mosaic of upland forests, peatlands and ponds. AET is the dominant hydrologic flux in this environment, and any changes in AET will have an important influence on CO2 exchanges, especially in areas where land cover types have been disturbed by anthropogenic (e.g. oil and gas exploration and extraction, or forest harvesting) activities. This study examines the sensitivity of modeled (Priestley-Taylor) PET and the Priestley-Taylor coefficient, (α) in a region representative of the mixed-wood WBF to a) spatially variable and b) static inputs of vegetation canopy structure (e.g. surface

roughness (z0) and displacement height (d)) within three landcover types. The model results will be compared with total AET measured using the Bowen ratio energy balance (over pond landcover units) and eddy covariance (over peatland and upland/aspen landcover units). This will provide estimates of the sensitivity of PET to variable canopy structure. The sensitivity of land cover types to canopy structure influences on PET and AET will also be examined. This study will provide a rationale for using three-dimensional remotely-sensed estimates of canopy structure within PET modeling exercises.

Air Quality and Atmospheric Chemistry from Space to the Boundary Layer (Part 1) / Qualité de l'air et chimie de l'atmosphère de l'espace à la couche limite (Partie 1)

Room / Endroit (Pinnacle), Chair / Président (Xin Qiu), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C10.1 ID:3842 13:30

OSIRIS on Odin: The ninth year of a two year mission

Doug Degenstein , *Adam Bourassa*
University of Saskatchewan
Contact: adam.bourassa@usask.ca

The Canadian built OSIRIS instrument on the Odin satellite was launched in 2001 and began a nominal two year mission. Currently still in full operation, OSIRIS makes measurements of limb scattered sunlight spectra, covering UV, visible and near infrared wavelengths, that are used to retrieve vertical profiles of O3, NO2, BrO, and stratospheric aerosol extinction. This paper will highlight several features of this data set, including sampling, resolution, precision and the ability to detect long term trends.

4C10.2 ID:3710 13:45

10 Years of Pollution Data from the MOPITT Instrument

James Drummond [1], *Meritt Deeter* [2], *David Edwards* [2], *John Gille* [2], *Florian Nichitiu* [3], *Jason Zou* [3]
[1] Dalhousie University
[2] National Center for Atmospheric Research
[3] Toronto University

Contact: james.drummond@dal.ca

On 18th December 1999 the Terra platform was launched from the Vandenberg Air Force base carrying the Measurements Of Pollution In The Troposphere (MOPITT) instrument. MOPITT is now completing ten years of operation measuring carbon monoxide (CO) over the planet. These measurements have demonstrated the changes of CO in both space and time and shown a planet with very large variations in concentrations depending upon events and circumstances. Two of the major conclusions are that CO varies over time and space in such a manner that it is almost impossible to describe an “average year” and that pollution is always a global issue not a regional one.

This talk will review the overall MOPITT mission and what it has taught us about the science and engineering of measurements of CO in the atmosphere. There have been a number of challenges that have been successfully overcome to bring the instrument to the present time. Such a discussion leads naturally to consideration of the future improvements of both of MOPITT instrument datasets and future instruments using similar techniques.

MOPITT was provided to the Terra spacecraft by the Canadian Space Agency and was built by COMDEV of Cambridge, Ontario. Data processing is performed by the MOPITT team at the National Center for Atmospheric Research, Boulder, CO. Instrument control is by the team at the University of Toronto.

4C10.3 ID:3777 14:00

An Extreme CO pollution event over Indonesia measured by the MOPITT instrument and a possible lightning contribution.

Florian Nichitiu [1], *James Drummond* [2], *Jayanta Kar* [3], *Jason Zou* [1]
[1] Department of Physics, University of Toronto
[2] Department of Physics and Atmospheric Science, Dalhousie University,
[3] Science Systems and Applications Inc.
Contact: nichitiu@atmosp.physics.utoronto.ca

In the fall of 2006, the Measurements Of Pollution In The Troposphere (MOPITT) instrument on the Terra satellite observed an extremely high Carbon monoxide (CO) concentration over Indonesia. This extreme event was caused by huge fire activity during the 2006 El Nino event. Considering the fires and their possible relation with lightning we observed that more intense thunderstorms, defined here as Flashes per Storm (FPS), are more probable during large fire activity. From our comparison with other high CO pollution events over Indonesia during similar and moderate El Nino events, we conclude that the 2006 fire activity, which caused large-scale pollution in this region, was probably amplified by an increase in intensity of lightning activity in a feedback mechanism. We also observed that after the fire activity stopped and the rainy season began, the thunderstorm (lightning) activity was still affected by pollution. The FPS were less than during active fires and displayed a tendency toward intense lightning activity proportional to previous fire activity.

4C10.4 ID:3709 14:15

The Mission for Climate and Air Pollution (MCAP)

James Drummond [1], *Mcap Mission Team* [2]
[1] Dalhousie University
[2] Various
Contact: james.drummond@dal.ca

Climate change is one of the most challenging issues facing Canadians and air quality is a pressing issue in many Canadian cities. However, there is an interaction between these two issues: Climate change is expected to lead to a deterioration in air quality in eastern North America in the future.

The objective of the MCAP mission is to provide insight into understanding climate change and air quality processes; to provide input into air quality policy; and to provide predictive capability for future generations. This will be achieved by the acquisition of a global, precise dataset of atmospheric composition relevant to climate and air quality studies, co-located in space and time and acquired and analysed at the highest levels of scientific understanding available. Measurements of CO, NO2 , O3 , HCHO, SO2, BrO, CO2, CH4 , and clouds and aerosols will be made at a spatial resolution of 10km x 10km or better. These measurements will be analysed with climate and air quality models to improve both our understanding of the processes involved and our ability to forecast changes.

The MCAP spacecraft includes five instruments on a Canadian Multi-Mission Small Satellite Bus (MMSSB): a Correlation Radiometer, a Fourier Transform Spectrometer, an Infrared imager, a Multi-Angle Imager and a Solar Reflectance Spectrometer. Three of these instruments will be developed in Canada and two will be contributed from international partners.

The MCAP mission has been developed under the Atmospheric Processes of Climate Change (APOCC) initiative of the Canadian Space Agency (CSA). It has been supported by team members from ABB-Bomem Inc., COM DEV International Ltd., MacDonald, Dettwiler and Associates Ltd., University of Bremen and the Jet Propulsion Laboratory.

4C10.5 ID:3612 14:30

PREMIER - A Candidate ESA Earth Explorer Mission for space-based observations in the UTLS

Michaela I. Hegglin [1], *Brian Kerridge* [2], *Jack Mcconnell* [3], *Donal Murthag* [4], *Johannes Orphal* [5], *Vincent-Henri Peuch* [6], *Martin Riese* [7], *Michiel Van Weele* [8]
[1] University of Toronto
[2] RAL

[3] York University
[4] Chalmers University
[5] KIT
[6] Meteo-France
[7] FZJ
[8] KNMI
Contact: michaela@atmosp.physics.utoronto.ca

The PREMIER (PRocess Exploration through Measurements of Infrared and millimetre-wave Emitted Radiation) mission is one of three candidates for ESA's 7th Earth Explorer Core Mission (due for launch in 2016) which are currently in Phase A study. The mission proposes to make detailed measurements in the mid/upper troposphere and lower stratosphere in order to quantify processes controlling atmospheric global composition in this height range of particular importance to climate. PREMIER would consist of an infrared limb imaging spectrometer which would observe 3D fields of trace gases, alongside a millimetre-wave limb sounder which would enable observations in the presence of most cirrus clouds, and also provide complementary trace gases. In addition, co-located data from Eumetsat's EPS-MetOp would be combined with that from PREMIER, to extend the scientific impact of PREMIER down into the lower troposphere, to explore links to surface emissions and pollution. Data from PREMIER would be available also for assimilation into operational systems, to complement that from nadir-sounders on MetOp and other satellites. In this contribution we will discuss its relevance for atmospheric science and present simulations of its capabilities.

4C10.6 ID:4036 14:45

PCW/PHEMOS Arctic weather, climate and air quality

John Mcconnell [1], *Tom Mcelroy* [2], *Brian Solheim* [1], *Kaley Walker* [3], *Jacques Giroux* [4], *Peyman Rahnama* [5], *Phemos Team* [6]
[1] York University
[2] Environment Canada
[3] University of Toronto
[4] ABB Bomen
[5] COM DEV
[6] EC/ShU/UoS/DU/UW/UT/YU/
Contact: jcmcc@yorku.ca

The Arctic is a region of rapid climate change with warming temperatures and depleting summer ice which may be exacerbated by transport of soot and other anthropogenic material from mid-latitudes. It is also the source of winter storms delivering cold air to lower latitudes. Currently data is available for these areas from polar orbiting satellites, but only intermittently at a given location as the satellites pass overhead. The PCW (Polar Communications and Weather) mission proposes to use two satellites each in a 12 hour Molniya orbit (very high eccentricity with an apogee of ~ 6Re) which is a quasi-stationary orbit close to apogee (+/- 4 hours) to give 24x7 coverage of the Arctic region. The basic meteorological instrument is a multi-spectral imager similar to MODIS or ABI. CSA recently requested proposals to explore the possibility of science instruments for atmospheric, plasma and auroral science on PCW. A group of atmospheric scientists, together with ABB Bomen and COM DEV responded to the challenge. This report presents the case for the development of a suite of innovative imaging instruments (imaging FTS, UV-Vis-NIR spectrometer, SHS spectrometer for methane) to provide essential Arctic weather, climate and air quality data from the PCW satellite. Science goals of the instruments which will be used in concert with the PCW multi-spectral imager are the provision of basic weather information, the collection of synoptic-scale air quality (gas and aerosol) measurements over the Arctic to better understand the impact of industrial and agricultural pollution and boreal forest burning on the Arctic and the acquisition of column abundance data on methane over the Arctic to assess perturbations due to its increasing release from the permafrost and from shallowly buried clathrates. We will outline in more detail the objectives and the challenges.

Systems modelling for better Arctic policy / Modélisation de système pour une meilleure politique arctique

Room / Endroit (Bytowne), Chair / Président (Jennifer Verlaine Lukovich), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C11.1 ID:3440 INVITED/INVITÉ 13:30

Systems Approach for Policy Development

Slobodan Simonovic
University of Western Ontario
Contact: simonovic@uwo.ca

Policy development is facing great challenges – especially in the environmental and natural resources arena. Decisions about land use, competition for water, energy development, climate, natural hazards, public health and species protection are hard and may have multibillion-dollar implications, as well as consequences for human health, safety and quality of life. There is a critical need to adopt a new theoretical paradigm that will help the policy-science dialogue and policy development. Globalization and global change are phenomena that involve feedbacks between previously unconnected or largely independent physical and social systems. Therefore, I would propose that systems approach be used to explain the nature and consequences of their ever-closer linkages.

The fundamental tools of the systems approach have been in use for over 30 years and are now well established. However, they require a shift in the way we make the policy decisions. In particular, they require that we move away from looking at isolated situations and their causes, and start to look at the policy decision problems as a system made up of interacting parts. Systems approach provides diagramming languages to visually depict the feedback structures of these systems. Simulation is then used to play out the associated dynamics. These tools give us the ability to experience the consequences of our policy decisions, even if they are somewhere in the future.

One case study is selected to illustrate the utility of a systems approach to policy development. The case study focuses on the use of an integrated modeling tool designed to simulate the dynamics of the global society-biosphere-climate system. This tool is being developed to evaluate climate change mitigation options and provide support for international climate negotiations. The development process involves key federal stakeholders (Environment Canada; Fisheries and Oceans Canada; Natural Resources Canada; and Department of Finance Canada). The workshops with the stakeholders are designed to facilitate a dialogue between policy makers and scientists involved in the development and applications of the model. In this way, policy makers are benefiting from results of model calculations, while the modellers receive feedback from the policy makers on how to improve the policy relevance of the model.

4C11.2 ID:3467 INVITED/INVITÉ 14:00

Science-Policy Interface and Roles in Climate Change Adaptation

Gordon Mcbean
University of Western Ontario
Contact: gmcbean@uwo.ca

As the climate changes, the Arctic is one area of the globe that is now being impacted and will be even more so in the future. An important issue is how climate science information is and can be better input towards adaptation strategies. Further, how can the interests, knowledge and priorities of northern communities be best integrated with scientific information to inform policy makers. This paper will report on dialogue with northern leaders in policy development. It will also discuss the policy-making structures and the role of scientific studies. Connections with renewable and alternative energy technology development will be included.

4C11.3 ID:4468 14:30

Increasing the renewable energy ratio of northern communities

Eric Bibeau
University of Manitoba

Contact: lukovich@cc.umanitoba.ca

Northern remote communities rely on imported fossil fuels for most of their energy needs: heat, power and transportation. Although they live in a relatively low population density area and have access to renewable energy in the form of solar, wind, biomass, and often some form of hydro, they have developed a dependency on fossil fuels, subsidies and reliance that make it difficult to transition to a renewable energy based energy infrastructure. In addition, renewable energy technologies are developed for applications that achieve economies of scale and are often not well adapted to community needs. This situation is unlikely to change as remote communities are averse to supporting the development of renewable energy technologies suited to their needs, preferring instead to have these developed and fully tested elsewhere. This presentation will address how to increase the renewable energy ratio for remote communities. It will consider distributed renewable energy systems adapted to community needs. Because these communities cannot depend on utility grids, it is important that renewable energy technologies address key social factors: reliability, training and use of non-specialized labor. Various technologies will be reviewed that could apply in remote communities by taking cost and reliability into consideration, finding ways to meet energy demand with renewable energy generation, each having a strong intermittent component.

4C11.4 ID:3427 14:45

Response of Northern Hemisphere Lake Ice Cover and Thermal Structure to a Changing Climate

Yonas Dibike [1], *Terry Prowse* [2], *Roxanne Ahmed* [1], *Tuomo Saloranta* [3]
[1] Water and Climate Impacts Research Centre, Environment Canada at University of Victoria
[2] Water and Climate Impacts Research Centre, Department of Geography, University of Victoria
[3] Norwegian Institute for Water Research (NIVA)
Contact: yonas.dibike@ec.gc.ca

Freshwater ice plays an important role in physical, geochemical and biological processes in cold-regions lakes; therefore, the formation and breakup of ice are important seasonal events in mid- to high-latitude regions. Increasing concern has developed about how climate change and variability will affect lake water thermal structure and lake ice characteristics, particularly its formation, duration, breakup, thickness and composition. This study employs a one-dimensional processes based multi-year lake ice model, MyLake to simulate the evolution of the Northern Hemisphere lake-ice and thermal structure patterns under a changing climate. After testing the model on Baker Lake located in Nunavut in Canada, large scale simulations were conducted over the major land masses of the northern hemisphere subarctic regions between 40 and 75 degree north using hypothetical lakes located at 2.5º latitude and longitude resolution. For the baseline period of 1960 to 1999, the lake-ice model was driven by gridded atmospheric forcing from ERA-40 global reanalysis data set while model forcings corresponding to future (2040 – 2079) climatic were prepared by modifying the

ERA-40 data according to the Canadian Global Climate Model (CGCM3) projection based on the SRES A2 emissions scenario. Analysis of the simulation results indicate that the future warming will result in an overall increase in lake water temperature, with summer stratification starting early and extending later in to the year. The timing of freeze-up will be delayed by 10 to 20 days while break-up advance by approximately 10 to 30 days resulting in a decrease of lake-ice duration by about 20 to 50 days. The maximum lake-ice thickness will be reduced by 10 to 50cms and the change in maximum snow depth on the lake-ice ranges between -20 to +10cms while the change in snow-ice thickness range between -20 to +5cms depending on the geographic location, topography, nearness to coast lines and other climate parameters.

Crust to Core: Structure observations & models (Part 2) / De la croûte au noyau : observations de la structure et modèles (Partie 2)

Room / Endroit (York), Chair / Président (Catrina Alexandrakis and Jeff Gu), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C12.1 ID:4081 INVITED/INVITÉ 13:30

Lithospheric structure beneath the Western U.S. using USArray data

Meghan Miller [1], *Alan Levander* [2]
[1] University of Southern California
[2] Rice University
Contact: msmiller@usc.edu

Using a combination teleseismic data from the USArray Transportable Array, previous PASSCAL experiments, and the COARSE array in Arizona we have produced images of the lithospheric structure beneath the Western United States. We have made common conversion point (CCP) stacked Ps and Sp receiver function image volumes to determine, in more detail and higher resolution than previously obtained, the crustal thickness and the depth to the Moho and lithosphere-asthenosphere boundary (LAB) throughout the Western U.S. Individual receiver functions have been converted to depth and laterally "migrated" to their conversion point using 3D P- and S-wave tomography velocity models, (Schmandt and Humphreys, unpublished) with redundant signals stacked for signal enhancement. Both S and P receiver functions have imaged an unusually complex crust-mantle boundary region beneath the Colorado

Plateau in comparison to most other parts of the western U.S., although we also see features that correlate with expressions of lithospheric drips in the southern Sierra Nevada and the Wallowa Mountains. These complications in the Moho are correlated with low upper mantle velocities observed in P and S body wave tomography and S-velocity structure determined from Rayleigh wave inversion. Throughout the model, the LAB is a negative amplitude feature that has significant topographic variation, and cannot be described as a single surface. We see a particularly strong correlation between calculated equilibration pressures of primitive basalt whole rock samples from across the western United States, extracted from the NAVDAT database (http://navdat.kgs.ku.edu/), and the LAB estimate from the receiver function images beneath the southern Basin and Range, the Snake River Plain, the Cascades, the Colorado Plateau, and the Sierra Nevada. The depth estimates from the geochemistry data and comparison with the receiver function images allows us to interpret the lithosphere-asthenosphere boundary and its relation to the different tectonic provinces in the western United States. We will present different geologic scenarios that can explain these structures.

4C12.2 ID:3954 INVITED/INVITÉ 14:00

A seismological perspective on fluid transport in subduction zones

Stéphane Rondenay
MIT
Contact: rondenay@mit.edu

Subduction zones transport water into the Earth's interior. The subsequent release of this water through dehydration reactions may trigger intraslab earthquakes and arc volcanism, regulate slip on the plate interface, control plate buoyancy, and regulate the water budget on the planet's surface over long time scales. This presentation provides a review of recent seismological results that have helped characterize these hydrous reactions and how they affect water distribution in subduction systems. We present a high-resolution seismic imaging technique that, in conjunction with information from geodynamic models and petrological data, provides direct constraints on the depth range over which the downgoing plate undergoes dehydration and the degree of hydration-serpentinization of the mantle wedge. Applications of this technique to seismic data sets from subduction zones in Cascadia, Alaska, and Greece are presented. We find that the depth at which the oceanic crust transforms from hydrated metabasalts into eclogite is highly dependent on the age of the subducted slab: the youngest crust (Cascadia) undergoes eclogitization at 40 km depth, whereas the older crusts (Alaska and Greece) eclogitize at depths greater than 100 km, as expected from thermal models.

4C12.3 ID:3370 14:30

Determination of the Earth's structure in Fennoscandia from GRACE and implications on the optimal post-processing of GRACE data

Holger Steffen [1], *Patrick Wu* [1], *Hansheng Wang* [2]
[1] University of Calgary
[2] Chinese Academy of Sciences, Wuhan
Contact: sholger@ucalgary.ca

Analysis of data of the Gravity Recovery and Climate Experiment (GRACE) satellite mission allows us to identify regions of long-term mass changes such as the areas of Glacial Isostatic Adjustment (GIA) in North America and Fennoscandia. As there are now more than 7 years of data available, the determined trends are robust enough for the inference of viscosity structure of the Earth's mantle. In this study we focus on the Fennoscandian rebound area. In the first step, GRACE data are taken to fix the optimal radial (1D) viscosity profile and the lithospheric thickness combination, which are needed as background parameters in three -dimensional (3D) earth modeling. The results agree well to former works using relative sea-level and GPS data, showing a lithospheric thickness in Fennoscandia between 90 and 160 km and an upper mantle viscosity of about (2-4) x 10^20 Pa s. The lower mantle viscosity is not well retrievable. In the second step, GRACE data are used to constrain the 3D viscosity profile, which is currently applied in 3D spherical Finite Element modeling. In this case, the results also agree with former investigations, but GRACE data alone cannot tell if lateral heterogeneities in the mantle is due to thermal effect or changes in chemical composition. Furthermore, we solved GRACE-related questions such as implementation of an adequate filter technique and identification of the best reduction method for hydrological mass change signals. It turns out that the Gaussian filter techniques is the best for this type of investigation. The global hydrology models used in GRACE investigations still need improvement. In conclusion, our study clearly shows that GRACE data represents another dataset that can be used successfully in GIA investigations. As there is new GRACE release in progress, and also in view of new ice history models for the modeling that will be provided soon, GRACE will give more insight in earth structure and rheology within the next few years.

4C12.4 ID:3578 14:45

Normal modes of the Earth’s fluid core: an experimental study using Digital Imaging Velocimetry

Behnam Seyed-Mahmoud
University of Lethbridge
Contact: seyeb0@uleth.ca

Some of the inertial modes of a sphere and a spherical shell proportional to the Earth’s fluid core are excited using mechanical means. A camera and a laser module are mounted in the rotating frame so that when at solid body rotation there are minimal particle motions relative to the camera. Particle motions are then captured using Digital Imaging Velocimetry (DIV) when a mode is excited. We will show that both the particle velocity vectors and the modal frequencies match well with the predicted values. Although some of these modes had been

observed using different means, the present set up provides new means to study particle motion in the Earth’s fluid core.

Wind Energy / Énergie éolienne

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (Peter A Taylor), Date (04/06/2010), Time / Heure (13:30 - 15:00)

4C14.1 ID:4039 **13:30**

Tall tower measurements for wind energy resource assessment

Jim Salmon , *Paul Stalker*
Zephyr North Canada
Contact: pat@yorku.ca

While wind atlases and other estimates of the wind energy resource are extremely useful, at least one year of site specific hub height wind measurement is usually a requirement for wind farm developers in Canada. While there are multi-year Environment Canada wind data available at reference sites these are at 10m while hub heights are in the 60-100m range. Also the standard EC measurement is a short term average on the hour while resource assessment requires continuous 10-min average data for wind speed and direction plus various gust speed measurements. Ideally pressures and temperatures are also measured to determine air density – a factor in the energy available from the wind.

Quality control of the data is an essential component of the monitoring program. Zephyr North have been measuring winds from various 55-80 m towers for many years with several different anemometer and data logger combinations. Vertical extrapolation to hub heights and above is sometimes necessary. For longer term assessments MCP (Measure, Correlate, Predict) techniques utilizing nearby EC station data are often required. The presentation will review the various measurement and data processing methodologies needed, the problems likely to arise and will also discuss opportunities for measurement with lidar and sodar systems.

4C14.2 ID:4035 **INVITED/INVITÉ** **13:45**

Developing wind farms in Canada: resources, restrictions and rewards

David Timm [1], *Jim Salmon* [2]
[1] IPRCanada
[2] Zephyr North Canada
Contact: pat@yorku.ca

So you want to develop a wind farm! What are the steps and how many obstacles are there? It is a complex process and there are many pitfalls but AIM Powergen (now IPRCanada) and Zephyr North (now Zephyr North Canada) have done it successfully and can tell you a little about it.

As a preliminary step you need to know something about the wind resource in the general area and the Canadian and regional wind atlases will help. If it is on your own land you are in a good position but if you are developing a large farm you will need signed agreements with a number of land owners. If you have several hundred million dollars to spend you could proceed but if you need to borrow money, or if you are cautious, you need to make site specific wind resource measurements – ideally up to hub height or above and for at least a year to establish just how good the wind resource really is. You then need to design a layout for your farm, with maybe 50-100 large (2MW) wind turbines. The design needs to take account of local terrain, variations in surface roughness and the impact of wakes from upstream turbines. Often a significant problem is satisfying noise and other restrictions imposed by provincial agencies. There may also be grid access issues to negotiate. You have to find a supplier for the turbines – who will also need detailed wind regime information in order to recommend a suitable turbine model. that will be efficient, cost-effective and will survive extreme winds. The next step is to get it built, start operating and supplying power to the grid.

4C14.3 ID:3409 14:00

Comparing Low to Mid Atmospheric Wind Measurements with Model Results

Matthew Corkum , *Peter Taylor*
Department of Earth and Space Science, York University
Contact: corkumm@yorku.ca

Wind is becoming an important source of electrical power in Canada as the country pushes to produce 20% of its energy demand from wind by 2025 (It is currently at about 1%). As wind turbines increase in size and the percentage of electrical power produced increases, wind forecasting at hub heights of order 100m becomes more important.

The Ontario-Quebec VHF wind profiler radar network will consist of 10 wind profilers in southern Ontario and Quebec. These units use frequencies in the range 40 to 55 MHz and cover an altitude range of about 400 meters up to 10 or 15 km altitude. This data can potentially assist with the evaluation of forecasts for wind energy purposes.

Measurements from five of the wind profilers in Southern Ontario are being compared with model results from the 15 km Canadian regional GEM model and the 12 km North American Mesoscale Model. In addition, wind measurements from a lidar wind profiler to be installed soon on the Toronto Hydro Lake Ontario research platform will be compared with these model results.

4C14.4 ID:3983 14:15

Optimal Use of Short-Term Numerical Wind Predictions for Complex Sites Using a Geo-Referenced Weighting Module

Joël Bédard [1], *Wei Yu* [2], *Yves Gagnon* [3], *Christian Masson* [1]
[1] Canada Research Chair on the Aerodynamics of Wind Turbines in Nordic Environment, ÉTS
[2] Meteorological Research Division, Environment Canada
[3] K.C. Irving Chair in Sustainable Development, Université de Moncton
Contact: joel.bedard@hotmail.com

With the sustained growth of wind energy installed capacity for electricity generation, electricity system operators have increasing challenges balancing the electricity grid, notably in regards to minimizing the cost of other energy sources dispatch. Due to the intermittency of the wind, the wind power generation forecasting is an important issue for the economic viability of wind energy, whether in regulated markets or in open markets. Therefore, there is a pressing need for robust short-term (up to 48 hours) wind forecast models, and eventually for wind power forecast models, in order to sustain the integration of wind energy in electricity portfolio of jurisdictions. Based on the needs of the wind energy industry, almost 3 years of experimental meteorological forecasts in Eastern Canada are available from Environment Canada numerical wind predictions (NWP) model configured on a limited-area (GEM-LAM 2.5km) for wind power predictions. These data include forecasts for the region of North Cape (Prince Edward Island) where the Wind Energy Institute of Canada runs a test site for wind turbines. Preliminary statistical analysis and site inspection revealed that the model does not have sufficient grid spacing refinement to properly represent the meteorological phenomena on the complex coastal site, although the model resolution is already relatively high (2.5 km). For this reason, a geo-referenced weighting module has been developed and applied for optimal use of short-term NWP. This geo-referenced weighting module was tested with two years of experimental forecasts and it improved the predictions for all time horizons and almost all meteorological conditions. Although the current study presents the optimal use of short-term NWP for wind power forecasts using such module, it will also contribute to the development of a methodology and an analysis tool used to assess and understand the NWP uncertainties. Future work will extend these analyses to other complex sites.

4C14.5 ID:3627 14:30

OpenFOAM simulations of neutral atmospheric boundary layer flow over complex terrain

Jonathon Sumner , *Christian Masson*
École de technologie supérieure
Contact: jonathonsumner@hotmail.com

With wind farms being installed on increasingly complex sites, the use of computational fluid dynamics (CFD) for wind energy resource assessment and wind farm design is becoming more popular. This is largely attributable to its ability to capture non-linear flow effects, which may be dominant features where the topography is highly variable. Although predictions are generally better than with linear models for such cases, the nature of turbulent flows is such that modeling of turbulence effects is a necessity and appreciable uncertainty remains.

The lack of full-scale measurements with which to calibrate and test turbulence closure schemes contributes to this problem. With this in mind, Risoe DTU has recently carried out a detailed wind measurement campaign over the isolated presqu'ile of Bolund. The present work focuses on evaluating a RANS approach to resolve the flow over Bolund using the open source CFD code OpenFOAM. Specifically, the turbulence closure scheme, surface roughness treatment, upper boundary and inflow conditions, and meshing will be discussed. Of central interest for wind energy purposes is the estimation of mean velocity. In a blind comparison of CFD codes organized by Risoe DTU subsequent to the field campaign, the outlined methodology resulted in the smallest average error in terms of mean velocity with respect to available measurements.

4C14.6 ID:3963 **14:45**

A Non-Linear Mixed Spectral Finite-Difference 3-D Model of Neutral Planetary Boundary-Layer Flow over Complex Terrain

Wensong Weng
York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3
Contact: wweng@yorku.ca

Based on the early Non-Linear Mixed Spectral Finite-Difference (NLMSFD) model of Xu et al., a 3-D non-linear model of planetary boundary-layer flow (NLMSFD-PBL) was developed using the so-called 1.5 order E-ℓ turbulence closure. The model utilizes the results of early 1-D planetary boundary layer model of Weng and Taylor as the zero-order or upstream profiles of mean and turbulent quantities. The limitation placed on the original NLMSFD model due to the simple, surface-layer upstream profiles (e.g. logarithmic wind profile and constant shear stress layer) are relaxed. The effect of earth’s rotation is also included in model.

Model runs have been carried out for planetary boundary-layer flow over an idealized isolated 3-D terrain and the Askervein Hill --- the site of a detailed and much referenced field study of boundary-layer flow over hills in the 1980s. Model results are discussed and compared. This type of modelling of flow over complex terrain has important applications for wind energy resource assessment and wind farm design.

IPY and Related Atmospheric, Oceanographic, and Hydrological Studies (Part 3) / AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie (Partie 3)

Room / Endroit (Ballroom A), Chair / Président (Bechara Toulany and Will Perrie), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D01.1 ID:4028 **15:30**

The 2009 Major Stratospheric Warming: Observations and Analysis from the Polar Environment Atmospheric Research Laboratory (PEARL)

William E. Ward [1], *Alan Manson* [2], *Marianna Shepherd* [3], *Young-Min Cho* [3], *Sam Kristoffersen* [4], *Emily Mccullough* [5], *Chris Meek* [2], *Ding Yi Wang* [1], *Robert J. Sica* [5], *Kevin Strawbridge* [6], *Xiaoyong Xu* [2], *Jim Drummond* [7]
(Presented by *William Ward*)
[1] Dept of Physics, University of New Brunswick
[2] ISAS, University of Saskatchewan
[3] CRESS, York University
[4] Dept. of Physics, University of New Brunswick
[5] University of Western Ontario
[6] Environment Canada
[7] Dalhousie University
Contact: wward@unb.ca

During January, 2009, one of the largest major stratospheric warmings on record occurred in the northern Polar middle atmosphere. Instrumentation associated with the Waves and Coupling Processes Theme of the Polar Environment Atmospheric Research Laboratory (PEARL) were operating under favourable conditions (mainly clear skies) at this time. These included the E-Region Wind Interferometer, the meteor radar, the Spectral Airglow Temperature Imager SATI), the PEARL All-sky Imager, and the ozone lidar. This suite of instruments provided wind, temperature and constituent information on the warming from the stratosphere to the mesopause region. In combination with assimilated data and satellite data, these observations provide a unique view of atmospheric coupling throughout the atmosphere during this major event. In this presentation, the time evolution of this warming at various heights as seen by these instruments along with the global information provided by the assimilation and satellite data are presented. This observation set indicates that the effects of the warming penetrated to above 100 km.

4D01.2 ID:3776 15:45

Mesospheric Temperature and Atomic Oxygen Response during the January 2009 Major Stratospheric Warming

Marianna Shepherd
CRESS, York University
Contact: mshepher@yorku.ca

The study examines the response of the mesosphere/lower thermosphere to the major stratospheric warming (SSW) event from January 2009, as seen in the OH and O2 (0,1) Atmospheric band airglow observations nominally at 87 km and 94 km, respectively by a SATI (Spectral Airglow Temperature Imager) instrument installed at the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (80°N, 86°W) as part of the Canadian Network for the Detection of Atmospheric Change. At the time of the SSW the airglow emissions and the derived rotational temperatures appear depleted and decreased, followed by an enhancement of the airglow emission rates during the SSW recovery phase, while the temperatures returned to their pre-event state. An empirical relationship between OH airglow peak altitude determined by SABER and SATI integrated emission rates allowed perturbed OH and O2 (0,1) airglow altitudes to be assigned to the SATI observations. From these the O volume mixing ratio (VMR), corresponding to the observed OH and O2 (0,1) airglow emission rates were modeled. Atomic oxygen depletion by a factor of ~5 was observed during the SSW and lasted for about 5 days. During the SSW recovery phase the O VMR giving rise to the observed O2 (0,1) airglow emission rates increased by a factor of 3.5 from its pre-SSW level and 17 times from the peak of the SSW. Perturbations in the OH and O2 (0,1) airglow layers with periods of 4-, 6-, 8- and 12-h indicate non-linear interaction between zonally symmetric semidiurnal tides and planetary waves.

4D01.3 ID:3899 16:00

ERWIN-2 Wind Observations at Eureka during the 2009 Major Stratospheric Warming

Samuel Kristoffersen [1], *Stephen Brown* [2], *William Ward* [1]
[1] University of New Brunswick
[2] York University
Contact: y6qk7@unb.ca

The E-region wind interferometer, ERWIN-2 was installed at Eureka, Nunavut at the Polar Environment Atmospheric Research Laboratory in February, 2008 and has been operating during the winter months since then. This field widened Michelson interferometer measures winds in the E-region (~ 90 km altitude) using Doppler shifts in hydroxyl, oxygen green line and O2 airglow emssions. Each emission is viewed in sequence and for each emission, the four cardinal directions and zenith are viewed simultaneously. The measurement cycle occurs

in about 2 minutes with a wind precision of ~3 m/s or better. In this talk we review the operation of this instrument and present wind observations which were taken during the January, 2009 major stratospheric warming. Observed are significant tidal amplitudes and longer term multiday variations in the background wind.

4D01.4 ID:4077 **16:15**

Stratospheric Aerosol Layers in the High Canadian Arctic

Frans Olofson [1], *Robert Sica* [1], *Kevin Strawbridge* [2], *James Drummond* [3]
[1] The Department of Physics and Astronomy, The University of Western Ontario
[2] Environment Canada Centre For Atmospheric Research Experiments
[3] Department of Physics & Atmospheric Science, Dalhousie University
Contact: folofsso@uwo.ca

Some of the major uncertainties in predicting climate change are related to the effect of aerosols and clouds on the radiative forcing of the atmosphere. In the Arctic stratosphere aerosols can also assist in the destruction of ozone. Though the high-Arctic stratosphere is often said to be “clean” relative to mid-latitudes, aerosol layers exist and can persist for periods extending for more than one year.

A DIAL/Raman/Rayleigh lidar located in Eureka, Nunavut (80° N, 86° W) and jointly operated by the Canadian Network for the Detection of Environmental Change (CANDAC) and Environment Canada has made measurements during the Arctic polar sunrise for the last 3 years. The lidar transmitter is in the near UV region and the backscatter returns are measured in five detection channels. The lidar measures two Rayleigh and three Raman lines (two nitrogen and one water) to obtain height profiles of ozone, temperature and water vapor. One Rayleigh profile and the corresponding Raman profile together with nightly coincident radiosonde measurements are used to calculate the aerosol extinction and backscattering coefficients independently. These measurements allow for the calculation of the extinction-to-backscatter ratio, which relates the magnitude of anisotropic scattering and possible absorption to the amount of backscattering. Since the ratio depends on the size distribution, shape and composition it can be used to characterize the microphysical properties of the aerosol.

The lidar's measurements will be used to characterize the properties of stratospheric aerosols during the Arctic polar sunrise over Eureka. These measurements will give new information about the abundance of Arctic stratospheric aerosols as well as their properties.

4D01.5 ID:4054 **16:30**

A new depolarization channel for the CANDAC Raman-Mie-Rayleigh Lidar in the Canadian High Arctic

Emily Mccullough [1], *Graeme Nott* [2], *Thomas Duck* [2], *Robert Sica* [1], *James Drummond* [2]
[1] Department of Physics and Astronomy, University of Western Ontario

[2] Department of Physics and Atmospheric Science, Dalhousie University
Contact: emccull2@uwo.ca

The Canadian Network for the Detection of Atmospheric Change (CANDAC) Raman-Mie-Rayleigh Lidar (CRL) was installed in the Canadian High Arctic at Eureka, Nunavut (80°N, 86°W) in 2008-2009. Since then this remotely-operated system has been used to measure multi-wavelength aerosol extinction, water vapour mixing ratio, and tropospheric temperature profiles. In addition to existing particulate density and colour ratio capabilities, the ability to measure phase was recently added with the installation of a new channel. This depolarisation channel measures backscattered light parallel and perpendicular to that of the transmitted beam, enhancing cloud and aerosol measurements. The depolarization ratio can be used to discern between ice crystal and liquid water returns in tropospheric mixed-phase clouds, as is possible with millimeter cloud radar measurements, but can also separate returns from ice crystals and aerosols. Details of the depolarization channel installation and characterisation will be discussed along with first results.

4D01.6 ID:3990 16:45

Temperature, watervapour and clouds: Results from the CANDAC Raman lidar 2009-2010 winter campaign in Eureka, Nunavut

Jonathan Doyle , *Graeme Nott* , *Christopher Perro* , *Colin Pike-Thackray* , *Jason Hopper* , *Thomas Duck* , *James Drummond*
Dalhousie University
Contact: doylejg@dal.ca

The Canadian Network for the Detection of Atmospheric Change (CANDAC), a collaboration between several universities and government organizations, has established a suite of instruments in Eureka, Nunavut, Canada (79°59'N, 85°56'W). As part of this program, during International Polar Year Dalhousie University installed a Rayleigh-Mie-Raman lidar at the sea-level atmospheric laboratory, (ØPAL). The lidar was designed to study the thermodynamic and radiative environments of the high Arctic. Specifically to profile atmospheric aerosols, temperature and watervapour year round.

Presented here are initial results from an intensive wintertime measurement campaign using the new lidar. These measurements took place December 2009 through February 2010. Tropospheric temperatures and near-continuous watervapour profiles have not been measured before at this location and offer new possibilities for the study of ice and water cloud formation processes. Aerosols also play an important role, particularly in the stable, wintertime boundary layer. Measured aerosol, tropospheric temperature and watervapour profiles will be presented, along with comparisons with co-located instruments where possible.

Regional Climate Modelling (Part 5) / Modélisation régionale du climat (Partie 5)

Room / Endroit (Ballroom B), Chair / Président (Hélène Côté), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D02.1 ID:3418 15:30

Interactive Lakes in the Canadian Regional Climate Model (CRCM): Present State and Perspectives

Andrei Martynov , *Laxmi Sushama* , *René Laprise*
Centre ESCER, Université du Québec à Montreal
Contact: a.martynov@gmail.com

Interactive lakes are introduced into the Canadian Regional Climate Model (CRCM), aiming at better simulation of egional climate, particularly for lake-rich regions, such as the Canadian Shield and the Laurentian Great Lakes region. During the first phase, two 1D lake models were interactively coupled with CRCM4, the current operational version of the model. Decadal simulations with the coupled model over a domain covering the Great Lakes are presented and compared with simulations that did not take into account lakes or used a simple mixed-layer lake model. The lake coupling for both resolved and sub-grid lakes is currently being realised for the next (fifth) generation of the Canadian regional model (CRCM5), which is based on the GEM numerical weather prediction model. Preliminary simulation results are presented and compared with standard CRCM5 and with coupled CRCM4 simulations.

4D02.2 ID:3810 15:45

Future Climate in Canada: A Regional Modelling Approach for Permafrost Soils

Jean-Philippe Blanchette [1], *Laxmi Sushama* [2], *René Laprise* [1], *Michel Allard* [3], *Michel Giguère* [4], *Richard Harvey* [4], *Diana Verseghy* [5]
[1] Centre ESCER-UQÀM
[2] Canadian Regional Climate Modelling and Diagnostics Network
[3] Centre d'Études Nordiques, Université Laval
[4] Consortium Ouranos on Regional Climatology and Adaptation to Climate Change
[5] Environment Canada, Toronto, Canada
Contact: jpblanc@sca.uqam.ca

One of the biggest changes expected by climate modellers for northern climate lies in the response of permafrost soils to climate change. It is well accepted now that permafrost will experience a general degradation following the rise of air temperature during the 21st century, and, in doing so, it will affect not only the climate via positive feedbacks but also local populations and infrastructures. However, the actual challenge is to simulate these predicted changes of thermal and hydraulic soil states as best as possible with the tools currently available. This is why the new version of the Canadian Land Surface Scheme (CLASS) has been implemented in the Canadian Regional Climate Model (CRCM).

The operational version of CLASS currently used in the CRCM has two major problems for accurate soil modelling simulations, particularly for permafrost areas. First, the shallow soil depth configuration (4.1m) leads to unrealistic energy dynamics caused by the zero heat flux condition at the soil bottom boundary. Second, the three-layer soil configuration (0.1, 0.25 and 3.75m) completely prevents the possibility of resolving the active-layer thickness (ALT) in permafrost regions. These issues - among others - have been addressed in the new version of CLASS: it has a deeper soil configuration (e.g., 100m) and a flexible layering scheme with multiple soil layers (e.g., 20 layers). Moreover, organic matter parameterization has been added to soil properties, which means that it is now possible to represent peat in the top-soil layers.

Preliminary results based on coupled CLASS-CRCM simulations for present and future climates will be shown. Sensibility analyses on different configurations of the land surface scheme will also be discussed and compared with offline simulation tendencies. Offline simulations have already shown that having a deeper soil configuration and organic matter parameterization delay the near-surface permafrost degradation.

4D02.3 ID:3885 16:00

Canadian RCM Projected Changes to Soil Moisture Characteristics Jean-Philippe Morin, Laxmi Sushama

Jean-Philippe Morin
CRCMD-UQAM
Contact: jeanphilippemorin2@hotmail.com

Greenhouse gas induced warming will cause an intensification of the hydrologic cycle. Among all components of the hydrologic cycle, soil moisture changes are of special concern due to their direct impact on agriculture. This paper analyses projected changes to soil moisture characteristics over North America, as simulated by the Canadian RCM, for the 2041-2070 and 2070-2100 periods with respect to the 1971-2000 period. Preliminary results suggest drier conditions across a greater portion of North America in summer. Projected changes to soil moisture for other seasons as well as projected changes to land atmosphere coupling over the region will also be presented.

4D02.4 ID:3676 16:15

Low and high frequency variability as simulated by Regional Climate Models

Philippe Roy [1], *Philippe Gachon* [2], *René Laprise* [1]
[1] Université du Québec à Montréal
[2] Environment Canada, Adaptation & Impacts Research Section, Climate Research Division
Contact: roy@sca.uqam.ca

The study will focus on the intercomparison of multiple regional climate models (CRCM4, CRCM5, GEM-LAM, ECPC, MM5, RegCM3, WRFP), driven by both reanalyses (NCEP-NCAR) and global climate models (CGCM3, CCSM, HadCM3 and GFDL) over North America. We will assess their potential use to reproduce the atmospheric variability over three major regions of Canada, allowing the characterization of the modes of variability for the 1979-2003 timeframe.

More specifically, we will assess the capacity of regional models to reproduce the low and high frequency variability of the atmospheric variables, as constructed through a temporal decomposition of the raw signal (i.e. daily scale variable). The low and high frequency variability are analyzed using Empirical Orthogonal Functions (EOF) on both components. The validation of the variability will then be done by comparing the simulated patterns with those of reanalyses, such as NCEP and ERA40.

4D02.5 ID:3346 16:30

Dynamical downscaling approach: evaluation and validation over Southern Québec using interpolated observed daily time series

Loubna Benyahya
University of Québec in Montreal
Contact: loubna_benyahya@hotmail.com

Simulating spatial values of climatic variables from climate models and/or downscaling techniques is important to many environmental studies. However, the validation procedure of simulated values over various regions of Canada, especially concerning the surface extremes climate information, requires some daily or sub-daily data at the appropriate scale. In this perspective, the meteorological stations are often irregularly spaced and limited to small number. Therefore construction of continuous, gridded time series of climatic variables is needed. In order is to create continuous climatic data into a regular grid with 45 km resolution (i.e. horizontal resolution of the current Regional Climate Model), a Cubic Spline as an interpolation method is evaluated. Observed daily precipitation and air temperature for the 1960-1999 period at 69 weather stations in Southern Québec are compared with their interpolated data.

Weather and Climate Monitoring in Canada - Current operations and future

directions (Part 4)/ Monitoring du temps et du climat au Canada - Activités en cours et orientation future (Partie 4)

Room / Endroit (Ballroom C), Chair / Président (Michael Manore), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D03.1 ID:3713 **15:30**

Strategic directions for weather and climate monitoring in Canada

Jim Abraham , *Mike Manore*
Environment Canada
Contact: mike.manore@ec.gc.ca

The Weather and Environmental Monitoring Directorate of Environment Canada has developed a new strategic plan which calls for the development of a multi-participant 'Network of Networks' to meet Canada's weather, water, air quality and climate observing needs. The plan describes a leadership role for Environment Canada to define a national structure for an extended, cooperative observing network which encourages and facilitates all operators of observing systems to contribute their observations to a national data grid. The paper will outline Environment Canada's strategic plan for monitoring, and provide the foundation for a Question and Answer period to follow.

4D03.2 ID:3896 **15:45**

Mesonet Programs – Needs and Best Practices

William Callahan , *James Anderson*
AWS WeatherBug
Contact: janderson@weatherbug.com

There are many well documented and compelling needs for significant improvements in mesoscale meteorological observations throughout many parts of the world. This is evidenced by the fact that the vast majority of severe weather impacts and related life, property and economic losses are associated with mesoscale events such as tornados, thunderstorms, fronts, squall lines, etc. Additionally, the looming impacts of climate change are likely to vary substantially on a regional basis requiring more detailed information on a finer scale. Hence, development of comprehensive densely spaced observing systems can establish the critical information repositories needed to improve: short- and medium-term weather and wind forecasting down to local scales, climate monitoring on a regional basis, as well as decision support capabilities including plume dispersion modeling and air quality forecasting, to name a few.

While federal governments are well suited to act nationally and even globally, they are often limited in their capacities to act locally. Therefore, it is imperative that public/private/academic partnerships are formed to leverage the collective expertise, assets and technological know-how of each sector. Collaboration of this type is particularly germane given that many existing meso-networks have been deployed by local organizations with local considerations in mind. These stakeholders maintain the capacity to react quickly and efficiently and are best positioned to recommend future network evolution within their domains. Additionally, coordination will go a long way toward avoiding duplication of effort and promote both a robust private sector and wise expenditure of public funds.

This presentation will outline the major building blocks of a mesonet program and discuss best practices for a multi- tiered, multi-faceted “network of networks” approach that maximizes the value derived from leveraging existing assets and serves multiple needs. On-going activities within U.S. National Mesonet Program will be highlighted.

4D03.3 ID:3779 16:00

British Columbia’s Climate Related Monitoring Program – A Network of Networks Application

Ted Weick
(Presented by *Pat Wong*)
BC Ministry of Environment
Contact: ted.weick@gov.bc.ca

British Columbia is a Province of many environments, with weather and climate dominated by topographic influences and proximity to the Pacific Ocean. Environment Canada is charged with maintaining a long-term network for meteorological forecasting and climate monitoring. Provincially mandated meteorological networks have been automating and increasing in size to better respond to their operational requirements – for avalanche, fire weather, road weather and flood forecasting, irrigation and hydro electric generation. Climate change and variability are and will continue to impact public safety programs and hydrologic regimes in all areas of the province. A network of networks will improve the Provincial coverage of meteorological and climate data in the environments where climate change will have the largest impact.

The Province is creating a climate dataset using data from various operational and research networks. This will aid in maintaining a viable network of weather stations over the longer term, especially as operational and capital resources become tighter. This paper will outline BC’s experience and the challenges of creating climate data and harmonizing the technology and operating standards for meteorological networks in the province.

4D03.4 ID:4605 INVITED/INVITÉ 16:15

Question and Answer Session – Strategic Directions for Monitoring in Canada

Michael Manore
EC - Meteorological Service of Canada
Contact: mike.manore@ec.gc.ca

Audience members will be invited to ask questions to the presenters and comment on the proposed strategic directions for weather and climate observing in Canada. Comments and observations will be noted for consideration within Environment Canada's monitoring strategic plan.

Improved Cold Regions Hydrology Processes, Parameterisation, and Prediction (Part 4) / Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides (Partie 4)

Room / Endroit (Richelieu), Chair / Président (Sean Carey), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D04.1 ID:3387 **15:30**

A Model for Hourly Rates of Lake Evaporation

Raoul Granger , *Newell Hedstrom*
Environment Canada
Contact: raoul.granger@ec.gc.ca

The results of a field study of boundary layer behaviour and open water evaporation carried out on three small to medium-sized lakes in Western and Northern Canada are presented. On each lake, the open water evaporation was measured directly using eddy covariance equipment. The profiles of wind speed, air temperature and humidity were also obtained over the water surfaces and over the upwind land surface, allowing for an examination of the effect of lake-land contrasts on the evaporation rates. The study showed that for time periods shorter than daily, the open water evaporation bears no relationship to the net

radiation. The wind speed and the land-water temperature contrast are the most significant factors governing the evaporation rates. Examination of the seasonal trends shows that the open water period can be separated into two distinct evaporative regimes: the warming period in the Spring, when the land temperature is greater than the water temperature, the turbulent fluxes over water are suppressed; and the cooling period, when the water temperature is greater than the air temperature, and the turbulent fluxes over water are enhanced. Relationships were developed between the hourly rates of lake evaporation and those significant parameters (wind speed, land-water temperature and humidity contrasts, and the downwind distance from shore). The result is a relatively simple versatile model for estimating the hourly lake evaporation rates. The model was tested using two independent data sets. Results show that the modeled evaporation follows the observed values very well; the model follows the diurnal trends and responds correctly to sudden changes in environmental conditions.

4D04.2 ID:3412 15:45

The Hydrological Functions of a Boreal Wetland

Christopher Spence [1], *Xiu Juan Guan* [2], *Ross Phillips* [2]
[1] Environment Canada
[2] University of Saskatchewan
Contact: chris.spence@ec.gc.ca

Boreal stream networks exemplify heterogeneous catchment conditions because they are embedded in a mosaic of wetlands and lakes in a forest landscape encompassed in a cold climate. This mosaic results in dynamic water chemistry signals and a complex hydrology. Of critical importance to catchment hydrology and water chemistry regimes are the wetlands, because they often occupy a position at the outlet of headwater basins. There is understanding of the runoff generation processes predominant in these wetlands throughout the year and how this impacts the chemistry of the water exiting the catchment. However, an investigation meant to improve understanding of the dynamic of wetland hydrological function is absent. The topics addressed in this presentation include the nature of the collection, storage, transmitting and contributing functions of one typical wetland in Canada's Precambrian Shield. The wetland appears to have three functional phases. During the first phase, the wetland provides a pipeline for streamflow from higher parts of the watershed, contributing little water relative to the amount transmitted. There is a short period during which upslope and intra-wetland sources provide comparable amounts to the outlet. During the last phase, inputs from the watershed have ceased and only water resident in the wetland is contributing to outflow. However, the chemical composition of this outflow indicates that it is the water that was stored adjacent to the bisecting stream earlier in the year and not water that came from pluvial or adjacent hillslopes. These results have implications for how hydrological models represent heterogeneous catchment conditions or how they may be coupled to biogeochemical models.

4D04.3 ID:3964 16:00

The influences of heterogeneity on connectivity at the drainage basin scale

Ross Phillips [1], *Christopher Spence* [2], *John Pomeroy* [1]
[1] Centre for Hydrology, University of Saskatchewan
[2] Environment Canada
Contact: ross.w.phillips@gmail.com

A drainage basin's runoff response can be determined by the connectivity of generated runoff to the stream network and the connectivity of the downstream drainage network. The connectivity of a drainage basin modulates its ability to respond to precipitation events and is a function of the complex and variable storage capacities throughout the drainage basin and along the drainage network. The influence of landscape heterogeneity on connectivity dynamics is poorly understood. At a 150 km2 subarctic Precambrian Shield catchment where the heterogeneous mosaic of lakes, exposed bedrock, and soil filled areas creates variable contributing areas, hydrological connectivity was measured prior to rain events in four disparate tributary basins. The four sub-basins, although of similar relative size, vary considerably in the dominant typology and topology of their constituent elements. At a 10m spatial resolution, saturated areas were mapped using both multispectral satellite imagery and on site measurements of storage according to land cover. To measure basin scale hydrological connectivity, the drainage network was treated as a graph network with stream reaches being the edges that connect sub-basin nodes. Connectivity was measured as the fraction of active relative to potential stream reaches as well as the size of the active drainage network connected to the outlet in each sub-basin. The impact of the type and location of elements, specifically lakes and wetlands, along the drainage network was deduced based on variations in connectivity between the different sub-basins. Results allude to the exceptional importance of particular land cover types accentuated by topology in determining drainage basin scale connectivity.

4D04.4 ID:3516 16:15

Run-off generation from aggregates of peat plateaus in the discontinuous permafrost zone of the NWT

Brendan Christensen [1], *Masaki Hayashi* [1], *William Quinton* [2], *Laura Chasmer* [2]
[1] University of Calgary
[2] Wilfrid Laurier University
Contact: bschrist@ucalgary.ca

Peat plateaus have a strong influence on the hydrological characteristics of basins within the discontinuous permafrost zone of the North West Territories (NWT). Recent studies have developed a quasi-three dimensional coupled heat and water transfer model simulating seasonal frost table thaw and subsequent runoff generation for individual permafrost plateaus. Although effective in

simulating runoff generation from a single peat plateau, this model is computationally intensive and impractical for modeling the mosaic of peat plateaus that define the discontinuous permafrost zone. A simpler approach was used to extend this model to a basin wide scale (1km x 1km), relating the physically based heat and water transfer model to the geometry of peat plateaus. The geometric parameters of peat plateaus, such as area, perimeter and height, have a strong influence on runoff volume and timing. To determine the relationship between these geometric parameters and runoff generation, the modelled hydraulic response of individual plateaus was compared to the plateaus area, perimeter and height. A relationship was derived for the individual response of a peat plateau to the basic plateau geometry. The individual response was then up-scaled to the aggregate response of peat plateaus over an entire basin based on the statistical distribution of plateau geometries. The Scotty Creek research basin in the NWT was used to verify the model. Scotty Creek lies in the discontinuous permafrost zone, just south of Fort Simpson, in the south-west portion of the NWT. This site is characterized by peat plateaus underlain with permafrost, supporting thriving black spruce forest. The peat plateaus stand 1 to 2 meters above the surrounding interconnected bogs and fens, where the plateaus act as the only source of runoff generation. The Scotty Creek basin is representative of many basins where the hydrological response is governed by runoff generation from peat plateaus.

4D04.5 ID:4001 **16:30**

Observed Streamflow Response Trends of the Upper Yukon River, Canada

Richard Janowicz
Yukon Water Resources
Contact: richard.janowicz@gov.yk.ca

While there is as yet no definitive evidence to prove that climate variability in the northern Canada is anthropogenic, air temperature and precipitation in Yukon Territory have fluctuated significantly over the last century. Yukon air temperature trends have been observed to change over the last several decades with an increase in annual, summer and winter air temperatures, while changes in precipitation have not been consistent with slight increases in summer precipitation and significant decreases in winter precipitation in southwestern Yukon. Changes to Yukon hydrologic response has likewise been observed in recent decades. In nival systems the timing of the freshet has generally advanced throughout Yukon, followed by lower summer and fall discharge. Winter low flows have increased significantly in permafrost regions, while some peak flow have decreased possibly due to degrading permafrost and subsequent greater infiltration to groundwater systems. The upper Yukon River basin contains the largest highland ice fields in North America, which are extremely susceptible to climate warming. While hydrologic response from glacier fed catchments in western Canada and the United States has been characterized with decreasing peak and summer flows, discharge in the upper Yukon River has increased significantly. Annual mean, summer and peak flows were observed to have increased in southwestern Yukon and northern British Columbia over the last several decades. These increases correspond to the observed increase in both summer temperatures. Annual mean, maximum summer flows were assessed using the Mann-Kendall test to statistically validate observed trends The observed changes have significant implications pertaining to public safety, and economic impacts to property and infrastructure, transportation networks and hydroelectric operations.

Cryosphere-Climate Feedbacks / Cryosphère : rétroaction cryosphère-climat

Room / Endroit (Frontenac), Chair / Président (Paul J Kushner), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D05.1 ID:3539 INVITED/INVITÉ 15:30

Solar heating, reduced snow cover, and warming from carbonaceous particles

Mark Flanner [1], *Charlie Zender* [2], *Peter Hess* [3], *Natalie Mahowald* [3], *Tom Painter* [4], *Vv Ramanathan* [5], *Phil Rasch* [6]
[1] University of Michigan
[2] University of California - Irvine
[3] Cornell University
[4] University of Utah
[5] University of California - San Diego
[6] Pacific Northwest National Laboratory
Contact: flanner@umich.edu

Atmospheric aerosols exert a unique influence on the solar radiation budget of snow-covered regions, where surface albedo is extremely high. Carbonaceous particles, an established component of "Arctic haze," can influence snow and ice cover by warming the atmosphere, reducing surface-incident solar energy ("dimming"), and reducing snow reflectance after deposition ("darkening"). We apply a coupled snow-atmosphere radiative transfer model and the NCAR Community Atmosphere Model to study these processes, drawing several conclusions: 1) Nearly all atmospheric particles (those with visible-band single-scatter albedo less than 0.999), including all mixtures of black carbon (BC) and organic matter (OM), increase net solar heating of the atmosphere-snow column. 2) Surface darkening caused by particles within snow generally exceeds the loss of absorbed energy from concurrent dimming, and over global snow we estimate 6-fold greater darkening than dimming, caused by BC+OM. This positive forcing reaches a maximum during boreal spring (in seasonally snow-covered regions) and summer (in polar regions), when local insolation becomes intense but large expanses are still snow- and ice-covered. 3) Equilibrium climate experiments suggest that fossil fuel and biofuel emissions of BC+OM induce 95% as much springtime snow cover loss over Eurasia as anthropogenic carbon dioxide, a consequence of strong snow-albedo feedback and large BC+OM emissions from Asia. Darkening from BC and mineral dust exerts 3-fold greater forcing on springtime snow over Eurasia (3.9 W/m2) than North America (1.2 W/m2). Inclusion of this forcing significantly improves simulated high-latitude continental warming trends, via reduced snow cover, but low biases persist in rate of spring snow cover decline.

4D05.2 ID:3883 16:00

Using new observational data to evaluate CMIP3 model predictions of snow- albedo feedback and its effects on future climate

Christopher Fletcher [1], *Paul Kushner* [1], *Hongxu Zhao* [2], *Richard Fernandes* [3]
[1] University of Toronto
[2] Environment Canada
[3] Natural Resources Canada
Contact: chris.fletcher@utoronto.ca

Snow-albedo feedback (SAF) is expected to have both global and regional impacts on future climate, through changes to the climate sensitivity and through amplification of local land surface warming. This could have important implications for the climate and hydrology of high latitude regions. Yet, the current generation of climate models shows a large spread in predictions of how strong the SAF might be. Our work has focused on (a) using new observational datasets to produce a detailed comparison with models of SAF derived from the present-day seasonal cycle, (b) diagnosing potential sources of the inter-model spread in SAF strength and (c) assessing the role of SAF in future changes to the large-scale atmospheric circulation. Our key findings show that the multi-model ensemble mean SAF matches observations very closely but the spread among models is large. We present a simplified method for decomposing the total SAF into two distinct components, one controlled by the albedo contrast between snow-covered and snow-free ground (SC), the other controlled by snow metamorphosis (META). In contrast to previous studies, we find a significant multi-model spread in META and show that SC and META explain similar fractions of variance of the total SAF, particularly over higher latitudes. We discuss potential implications of these findings for regional predictions of climate change and for future climate model development.

4D05.3 ID:3324 16:15

Wind-Driven Polynya Dynamics with a Mass and Momentum Conserving, One-Dimensional Model.

Andrew Willmott , *Miguel Maqueda* , *Ian Walkington*
Proudman Oceanographic Laboratory

Contact: ajwil@pol.ac.uk

The dynamics of wind-driven polynyas have been often investigated with relatively simple flux models that use the ice mass balance equation to calculate polynya evolution. Flux models alllow to simulate polynya evolution in a simple and computationally inexpensive way, and have been extensively used to evaluate ice production and dense water formation in polynyas over the Arctic shelves and around Antarctica. In flux models, steady surface forcing (wind stress and heat fluxes) leads to polynyas that open to a steady-state width in timescales ranging from hours to a few days. However, when the ice mass balance equation, which is the base of the polynya flux model concept, is supplemented with an equation for the conservation of ice linear momentum, the modelled polynya behavior changes and, in particular, steady-state polynyas are not always attainable. We discuss the implications of this results for our understanding of polynya dynamics and for our ability to model, or parameterize, polynyas in large-scale ocean-sea ice models.

4D05.4 ID:3512 16:30

Ice beacon trajectories in the Arctic during the IPY-Circumpolar Flaw Lead (CFL) study

Jennifer Lukovich , *David Babb* , *David Barber*
University of Manitoba
Contact: lukovich@cc.umanitoba.ca

Sea ice motion in the Beaufort Sea is characterized by predominantly anticyclonic activity during winter months, with episodic reversals to cyclonic activity during summer. Recent studies have however shown an increase in cyclonic activity throughout the annual cycle. In this paper we examine circulation in the Beaufort Sea based on the trajectories of 22 ice beacons launched in the Franklin Bay area during the CFL study. Investigated in particular is atmospheric and oceanic forcing of sea ice from November, 2007 to May, 2008 through analysis of dominant spatial and temporal scales in daily winds and ocean currents. Relative contributions from atmospheric and oceanic forcing mechanisms are determined through a lagged correlation analysis between sea ice motion, winds and ocean currents. Dispersion characteristics of ice motion are also explored by computing the absolute displacement of beacon trajectories from their origin. Results from this analysis highlight predominance in zonal winds responsible for westward advection of ice beacons in winter, 2008, while providing insight into local and nonlocal interactions that characterize ice transport within a rapidly changing region of the Arctic.

4D05.5 ID:3929 16:45

Declining Sea Ice and North American Precipitation

Melissa Gervais , *Bruno Tremblay* , *John Gyakum* , *Eyad Atallah*
McGill University

Contact: melissa.gervais@mail.mcgill.ca

Arctic sea ice has received growing attention due to concerns over decreasing trends in its extent. Although severe droughts in North America over the instrumental record have been linked to sustained La Nina conditions, it is suggested that additional forcings aid in causing the dryer conditions found in climate predictions [1]. This work investigates the effect of changing sea ice conditions in the arctic ocean on precipitation patterns in North America. To conduct this analysis, a 0.25 x 0.25 degree gridded precipitation data set for all of North America from 1961-2008 has been created through the amalgamation of the Climate Prediction Centers Daily US Unified Precipitation for the United States and the Daily Gridded Climate Dataset for Canada from Agriculture Canada. We present a preliminary analysis on the potential link between changes in sea ice concentration in various marginal seas and North American climate observations. In particular, indices of sea ice concentration in various marginal seas are created from the Hadley Center's HADISST sea ice concentration data set. These indices are regressed onto the gridded precipitation field as well as sea level pressure and temperature fields from NCEP reanalysis. Future work will include running the atmospheric component (stand alone) of the CCSM3 mode with prescribed sea ice conditions representing ice free/covered conditions in one peripheral sea at a time.

[1] R.Seager et al., Nature, 315, 1181-1184 (2007).

Storm Studies in the Arctic (STAR) (Part 2) / Programme Storm Studies in the Arctic (STAR) (Partie 2)

Room / Endroit (Joliet), Chair / Président (John M. Hanesiak), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D06.1 ID:3768 15:30

Weather Forecasting Skill in the Arctic

Gordon Mcbean , *Ken Porter*
University of Western Ontario
Contact: gmcbean@uwo.ca

Many people in the north travel over land and water for work and recreation. As the climate changes, weather events are being seen to be more unpredictable. An important question is then, what is the skill of public weather forecasts in the

Arctic, compared to those in southern Canada. If the skill is less, what are the factors that explain the differences? This paper will examine the variations in forecast skill in the north compared to the south – using the aviation forecasts as a measure of skill. Possible factors include location of forecasters; quality and number of regional weather observations – surface, upper air, radar, satellite; skill of NWP guidance information; and specific conditions of topography and local weather. The paper will also examine whether weather is becoming more variable and unpredictable.

4D06.2 ID:3615 15:45

Characteristics of Upslope Precipitation in the Arctic during STAR

Shannon Fargey [1], *John Hanesiak* [1], *Rebekah Martin* [1], *Walter Strapp* [2], *Mengistu Wolde* [3]
[1] University of Manitoba
[2] Environment Canada
[3] National Research Council of Canada
Contact: shannon_fargey@umanitoba.ca

Forecasting the onset, duration and amount of precipitation associated with upslope flow in the Arctic is a continuing operational and modelling challenge. The harsh climate, complex topography and expense related to maintaining ground-based instruments make it difficult to collect data that contains the level of detail required to verify model output. During the Storm Studies in the Arctic (STAR) project (2007-2008), orographic precipitation, as well as other weather features, were sampled in the eastern Canadian Arctic. The project focused on southern Baffin Island, Nunavut, which contains some of the highest mountains in Canada after the Rockies. Upslope precipitation was profiled using the National Research Council of Canada's (NRC) Convair- 580 aircraft. Data from five research flights are used to identify the physical processes associated with terrain induced or enhanced precipitation in the Arctic. Measurements from dual wavelength (W and X-band) Doppler radar detailed cloud dynamics and structure during events. Dropsondes were released in various regions, to characterize the thermodynamic state of the atmosphere both upstream and over topography. Using 2-D cloud particle imaging probes, a comprehensive investigation of the microphysical characteristics was completed, including: particle type, concentration and size. Our current understanding of upslope precipitation in the Arctic is limited. The data collected during the STAR project allows for a more comprehensive analysis of precipitation processes at high latitudes. The talk will highlight results to date from theses case studies during STAR.

4D06.3 ID:3614 16:00

Analysis of a Baffin Island storm during the STAR project

Shunli Zhang [1], *John Hanesiak* [2], *Rebekah Martin* [2], *Zhuo Liu* [2], *Shannon Fargey* [2], *Dylan Jones* [1]
[1] Department of Physics, University of Toronto

[2] Centre for Earth Observation Science, University of Manitoba
Contact: shunli@atmosp.physics.utoronto.ca

The Storm Studies in the Arctic (STAR) field campaign was conducted between 10 October and 5 December 2007 to provide a better understanding of the structure and dynamics of storms in the Canadian Artic. During the STAR campaign, a wide variety of data were collected by ground-based instruments, research aircraft and radiosondes.

In this study, a storm event on 17-18 November 2007, which was observed as the most significant storm during STAR campaign, is investigated using the unique STAR data and North American Regional Reanalysis (NARR). During this event, an extra-tropical cyclone intensified due to the forcing from upper level potential vorticity (PV) anomaly while travelling northward from eastern Canada to Baffin Island. The relative intense precipitation in southern Baffin Island resulted from the cold and warm fronts associated with the extra-tropical cyclone. The features of fronts are presented based on the data of radionsondes with high temporal resolution at Iqaliut and dropsondes from the research aircraft. Both radionsonde data and PV analysis demonstrate the dry intrusions associated with the extra-tropical cyclone development. In some places, the dry intrusion appeared to undercut the convective clouds and diminish the snowfall.

4D06.4 ID:3976 16:15

Using CloudSat and Aqua satellite data to analyze the cloud fields of four major storm systems observed during STAR

Alex Laplante [1], *Ronald Stewart* [2], *William Henson* [1]
[1] McGill University
[2] University of Manitoba
Contact: alexander.laplante@mail.mcgill.ca

The capability of researching clouds and their associated precipitation fields varies from region to region depending on the remoteness of the area and the accessibility of various technologies. Compared to the mid-latitudes, gathering observational information on weather systems is extremely difficult across the Canadian Arctic.

In an attempt to resolve this issue, the following research aims to improve our understanding of clouds and precipitation features over southern Baffin Island and the adjacent oceanic regions, especially in relation to major low pressure systems. To achieve this, CloudSat and Aqua satellite data obtained for a two-month period encompassing four major events (including the remnants of Hurricane Noel) were analyzed, corresponding with the Storm Studies in the Arctic (STAR) field research project. In total, orbital data across the four major events covered a total horizontal distance of 4431 km.

With the available satellite data, an analysis of cloud and precipitation features of

four storm systems was carried out. In contrast to the mean of cloud features observed during STAR, the four events were characterized as deep systems (> 5 km thick) with high cloud tops (more than 65% of cloud tops > 7 km ASL) and some layering (up to 4 layers). Cloud top features for each event also included low temperature values (as low as -65C). Additionally, strong vertical and horizontal variations in reflectivity, as well as regions of sublimation/evaporation aloft and/or orographic precipitation, were also observed. These and other results will be discussed in the presentation.

4D06.5 ID:3821 16:30

Building Successful Partnerships for Science Outreach in Nunavut

Robert Hodgson [1], *Sarah Wade* [2], *Teresa Fisico* [1], *John Hanesiak* [1]
[1] University of Manitoba - STAR
[2] Nunavut Dept. of Education
Contact: hodgsonr@cc.umanitoba.ca

Scientific research programs are under increasing pressure to communicate their activities and results to stakeholders and the public. Research networks want to establish legacy material that will extend the profile of the network and its findings beyond the specific duration of the network. Communication of science to non-mainstream public audiences such as those found in Canada's North presents additional challenges. The Storm Studies in the Arctic Research Network (STAR) recently began an outreach initiative, with the objective to engage people in the study region in the discussion of weather related issues. Mostly by happenstance, STAR entered into a relationship with the Nunavut Department of Education built around the development of curriculum materials related to atmospheric science. Although we are still in the early stages of material development, the relationship is proving to be a fruitful one for both parties and lessons learned through this example of scientific outreach can be applied easily and hopefully with equal success. This talk will review the valuable lessons learned to date through this relationship and put them into context with scientific outreach objectives and planning, especially for those projects engaging audiences similar to those in Nunavut.

Air Quality and Atmospheric Chemistry from Space to the Boundary Layer (Part 2) / Qualité de l'air et chimie de l'atmosphère de l'espace à la couche limite (Partie 2)

Room / Endroit (Chaudière), Chair / Président (John C. McConnell), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D07.1 ID:3807 15:30

Potential selection biases in satellite observations of NO_2 and SO_2 due to clouds

Jeffrey Geddes [1], *Jennifer Murphy* [1], *Jason O'Brien* [2], *Edward Celarier* [3]
[1] Department of Chemistry, University of Toronto, Toronto, ON
[2] Air Quality Research Divison, Environment Canada, Toronto, ON
[3] NASA GSFC, SGT, Inc., Greenbelt, MD
Contact: jeff.geddes@utoronto.ca

Satellite observations of tropospheric pollutants have the potential to expand the spatial coverage available from current ground-based measurements, improving emission budgets, epidemiological studies, and chemical models. However, accurate observations during cloudy conditions remain challenging. Most validation studies focus on cloud-free conditions by excluding observations with cloud fractions of greater than 0.2-0.3, reducing the temporal coverage of pollutants we may obtain from space. Furthermore, for some pollutants that are involved in photochemical and cloud processes, and for locations where pollutant transport is correlated with cloudy conditions, this focus could introduce biases in satellite-derived climatologies. This potential bias was investigated by analyzing ground-based measurements of NO_x and SO_2 (each strongly dependent on photochemical and cloud conditions respectively), and meteorological observations from two government monitoring sites in Ontario representative of urban and rural environments. By using the Ozone Monitoring Instrument cloud fraction as a filter, we show there is not only a significant seasonal selection bias due to the seasonality in cloud coverage, but that there is evidence of a strong bias in the summer due to long-range transport, photochemistry, and heterogeneous processes. Midday NO_2 mixing ratios and the NO_x/NO_y fraction are particularly affected at a "receptor" rural site where pollutant levels are strongly determined by regional transport, and the fraction of sulfur present as gaseous SO_2 vs particle phase SO_4^{2-} is also affected by cloud conditions.

4D07.2 ID:4003 15:45

Inverse modelling estimates of carbon fluxes using satellite observations of CO_2 from the Tropospheric Emission Spectrometer (TES)

Ray Nassar [1], *Dylan Jones* [1], *Susan Kulawik* [2], *Jing Chen* [1], *Parvadha Suntharalingam* [3], *Robert Andres* [4]
[1] University of Toronto
[2] Jet Propulsion Laboratory - California Insititute of Technology
[3] University of East Anglia
[4] Oak Ridge National Laboratory
Contact: rnassar@atmosp.physics.utoronto.ca

The strength of carbon sources and sinks can be estimated from a set of

atmospheric measurements and a model simulation of CO_2 using a Bayesian inversion approach. This approach has traditionally been used with ground-based measurements; however, the capability to retrieve CO_2 from observations by the Tropospheric Emission Spectrometer (TES) on the Aura satellite, has recently been developed. Although the sensitivity of TES CO_2 observations peaks in the mid-troposphere (511 hPa) and TES CO_2 accuracy and precision are lower than those of ground-based in situ measurements, the coverage provided by TES provides an important benefit for flux inversions. A comparison of inverse modeling estimates of carbon sources/sinks obtained using TES CO_2 and the GEOS-Chem global 3-D CO_2 simulation with multiple updates (including a chemical source of CO_2 from reduced carbon oxidation), will be compared with inversion results based on the in situ surface network.

4D07.3 ID:3917 16:00

A Comparison of NO2 Vertical Column Densities and Aerosol Optical Properties determined using MAX-DOAS, satellites, and air quality modeling

Jamie Halla [1], *Thomas Wagner* [2], *Steffen Beirle* [2], *Kevin Strawbridge* [3], *Bernard Firanski* [3], *Paul Makar* [3], *Robert Mclaren* [1]
[1] CAC, York University
[2] MPI for Chemistry
[3] Environment Canada
Contact: jdhalla@yorku.ca

Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) is a passive DOAS technique that uses the measurement of scattered sunlight to determine the total differential slant column densities (DSCDs) of trace gas absorbers such as NO2, HCHO, O4, and other small molecules, along multiple axes with respect to the overhead zenith. MAX-DOAS measurements probe long path lengths and have the potential to yield information about the vertical distribution in the troposphere as well as the vertical column densities (VCDs) of absorbers. Determination of DSCDs and VCDs have advantages over point source measurements in that they are more sensitive to the total atmospheric load of a pollutant being transported to a region, and are relatively insensitive to dilution effects that result from variations in the boundary layer height. Measurements using a MAX-DOAS instrument were taken from June 20th – July 10th, 2007 in Ridgetown, ON, Canada, as part of the Border Air Quality and Meteorological Study (BAQS-Met) using elevation angles of 2, 4, 6, 10, 30 and 90 degrees. DSCDs for NO2 in the troposphere were determined throughout the whole study, and for HCHO for selected periods. By using the DOAS technique to fit the O4 collisional complex, along with Radiative Transfer Modeling (McArtim), we have determined the total aerosol optical depths, approximate aerosol layer heights, and the VCDs of NO2 and HCHO. These VCDs are then compared to tropospheric VCDs calculated from SCIAMACHY and OMI data, as well as the AURAMS air quality model.

4D07.4 ID:3480 **16:15**

Statistical Approach to Air Quality Forecasting in Ontario

Daniel Spitzer [1], *Melanie Mckay* [1], *David Yap* [2], *Zhuanshi He* [3], *James Sloan* [3]
[1] A-MAPS Environmental Inc.
[2] Ontario Ministry of the Environment
[3] Waterloo Centre for Atmospheric Sciences
Contact: dspitzer@amapsenv.com

Log-Linear multiple regression model and General Additive Model were applied for forecasting air quality in Ontario. In both models, the air pollutant concentration levels are expressed as functions depending of a set of predictors. Hourly forecasts of NO2 concentration levels were calculated for a full year air quality monitoring period (January 2008 –December 2008). Results of the NO2 concentration forecasting by both models for two sites in Ontario (Windsor and North Bay) were compared with the National Air Pollution Surveillance (NAPS) records. The validation process of the statistical forecasting approach included selection of the most significant predictors (meteorological and geographical parameters, environmental data) in the models, selection of the optimum model "training period", analysis and statement of the forecasting accuracy as well as selection of the most practical approach to the modelling. The study indicated that the yearly median values of NO2 forecasting errors of the optimized statistical approach, regarding the two investigated locations in Ontario, can be less than 5ppb. These statistical models are ideally suited to forecasting the abundances of relatively short-lived species that are not subject to long range atmospheric transport. Comparisons with NO2 predictions produced by the SMOKE/CMAQ regional air quality modelling system will be shown to illustrate the improvement that can be achieved by the use of these models for species such as NO2.

4D07.5 ID:4069 **16:30**

Episodic ozone pollution in the Lower Fraser Valley, BC: A tale of three episodes.

Nadya Moisseeva , *Douw Steyn*
UBC
Contact: dsteyn@eos.ubc.ca

The spatio-temporal characteristics of episodic ozone pollution in the Lower Fraser Valley of British Columbia have changed markedly over the past two decades. These changes are documented by Ainslie and Steyn (2007), who hypothesize that the changes have come about because of changes in ozone precursor emissions strength, driven by aggressive air quality management plans. We shed further light on this phenomenon by a parallel spatio-temporal analysis of three notable episodes, one in 1988, one in 1998 and one in 2009. These three episodes span the emissions reductions initiatives, and the analysis is designed to cast light on potential for future air quality management strategies. Our analysis is based on a combined air quality and meteorological definition of

an ozone episode. We show that emissions changes have resulted in an eastward movement of the ozone “plume” in the LFV, consistent with Ainslie and Steyn (2007). We investigate the particular meteorological conditions during each of these episodes, and show that the most recent episode is characterized by record high temperatures, and wind patterns consistent with a failure of the sea breeze. In spite of reduced total emissions, the unusual meteorological conditions provide a context in which ozone pollution can still exceed applicable standards. We speculate on the implications for ozone pollution episodes in changed climates.

Environmental Prediction in Canadian Cities / Prévisions environnementales pour les villes canadiennes

Room / Endroit (Capitale), Chair / Président (James A Voogt), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D08.1 ID:3501 **15:30**

The Environmental Prediction in Canadian Cities (EPiCC) Network

James Voogt [1], *Tim Oke* [2], *Onil Bergeron* [3], *Sylvie Leroyer* [4], *Stéphane Bélair* [4], *Mario Benjamin* [5], *Andreas Christen* [2], *Nicholas Coops* [6], *Jocelyn Mailhot* [4], *Ian Mckendry* [2], *Ian Strachan* [3], *Jinfei Wang* [1]
[1] Department of Geography, University of Western Ontario
[2] Department of Geography, University of British Columbia
[3] Department of Natural Resource Sciences, McGill University
[4] Meteorological Research Division, Environment Canada
[5] Meteorological Service of Canada - Operations Quebec
[6] Department of Forest Resource Management, University of British Columbia
Contact: javoogt@uwo.ca

The Environmental Prediction in Canadian Cities (EPiCC) network is a multi-year (2006-2010) project of university and government researchers intended to provide an urban energy balance model ready for implementation in the Canadian Meteorological Centre numerical weather prediction scheme. This presentation will provide an overview of the network components and its achievements to date.

Network observations include two years of surface energy balance measurements, including carbon fluxes, acquired at multiple sites in Montréal and Vancouver. Montréal studies focus on winter conditions when snowfall is often large and energy use for space heating is intense. In Vancouver the focus

is on water use for garden irrigation in summer. Short term intensive observational periods provide details of the evolution of urban snow cover following snow events, the role of vegetation and anthropogenic water use on urban evaporation, and the urban boundary layer evolution over Vancouver.

Remote sensing, including airborne LiDAR, high resolution satellite imagery and ground-based instrumentation, is used to provide a detailed analysis of the urban structure, including both built and vegetated elements and to assess urban surface properties, especially temperature and snow cover, and their impact on the surface radiation and energy balance.

The modeling component is modifying the TEB-ISBA (TEB - Town Energy Balance; ISBA - Interactions Soil-Biosphere-Atmosphere) model (Masson 2000, Noilhan and Planton 1989) model to provide better coupling between built-up and vegetated surfaces, a more realistic built-up surface representation, and improved parameterizations for the thermal roughness length and soil hydrology. Modelling will address both meso- and urban boundary layer scales, ultimately down to ~250 m, which will ultimately provide Canadians with urban weather forecasts in previously unattainable detail. An off-line version of the model has also been developed which can be used as a tool for various urban design applications.

4D08.2 ID:3934 15:45

Year-long urban-rural differences of the surface radiation and energy balance observed in and near Vancouver, BC

Andreas Christen [1], *Ben Crawford* [1], *Sue Grimmond* [2], *James Voogt* [3], *Timothy Oke* [1]
[1] University of British Columbia, Department of Geography / Atmospheric Science Program
[2] King’s College London, Department of Geography
[3] University of Western Ontario, Department of Geography
Contact: andreas.christen@ubc.ca

The Environmental Prediction in Canadian Cities (EPiCC) network is seeking to improve Canada’s weather forecasting and atmospheric emergency response system in urbanized areas and to establish detailed datasets that can be used to test urban canopy parameterizations and dispersion models under ‘Canadian’ conditions. Whilst the performance of current urban canopy parameterizations has been excellent at several relatively dry sites in densely-built areas - it has been less tested and less successful at more vegetated sites with extensive irrigation or under conditions with a snow pack.

A pair of energy balance stations was continuously operated in Vancouver, BC, between August 2008 and July 2009 as part of the Environmental Prediction in Canadian Cities network funded by CFCAS. A suburban radiation and flux tower (‘Vancouver-Sunset’) was located in a vegetated, residential area with dominantly single-family residences. The tower provided continuous time traces of all components of the radiation budget, and sensible and latent heat fluxes (by means of eddy covariance) in addition to regular climate and surface data, including soil conditions from several residential lawns. A rural site 16 km to the South over un- managed and non-irrigated grassland was equipped with similar instrumentation and served as a reference case. This pair of sites allows study of urban-rural differences in surface energy partitioning in the Mediterranean climate of the Canadian West-Coast.

We quantify differences in the radiation and energy balance, their diurnal and annual course, and discuss major causes and controls using source area models in combination with detailed surface data. In particular the effect of urban vegetation and garden irrigation on the summertime surface energy balance partitioning is evident in this dataset. Anthropogenic water release associated with irrigation / sprinkling of urban green-space is substantial in suburban residential areas, rivaling precipitation as the main source of external water availability. The wet-dry contrasts created by adjacent irrigated and paved or built surfaces are known to boost evaporation in a non-linear fashion. Urban-rural energy balance differences are also controlled by the soil water and thermal properties of the rural area and they change significantly over the annual cycle due to varying soil moisture and vegetation conditions.

4D08.3 ID:3833 16:00

Wintertime radiation and energy budget along an urbanization gradient in Montreal, Canada.

Onil Bergeron , *Ian Strachan*
McGill University
Contact: onil.bergeron@mcgill.ca

This study reports on the radiation and energy balance of three sites (rural, suburban, urban) located along an urbanization gradient in the Montreal, QC region for two winters (December-March) with contrasting snow regimes. The urban and suburban sites had similar albedo which was about half that at the rural site during the snow cover period. Temporal variability in albedo was attributable to the presence of snow on rooftops at the urban site and to a site-specific response to cloudiness at the suburban site. Available energy was mostly dissipated as sensible heat flux (QH) at the beginning of the winter season and mostly stored (deltaQS) towards the end of the winter at both urbanized sites. Energy partitioning into QH and deltaQS was correlated with air temperature with no significant differences between urbanized sites. Latent heat flux (QE) was low throughout winter and accounted for 10% of total available energy during daytime at the urbanized sites. On a daily time scale, available energy was mostly stored before noon and dissipated as QH in the afternoon at both urbanized sites. Urbanized sites showed differences in diurnal variability of energy balance components occurring in the afternoon and evening. Hourly estimates of winter anthropogenic heat flux (QF) were a significant term in the energy budget analysis. QF was dominated by heat loss from buildings at both

urbanized sites while vehicular traffic contributed to rush hour peaks.

4D08.4 ID:3489 16:15

Validation of the ISBA snow model in the context of Montreal urban and suburban snow.

Eric Christensen
McGill University
Contact: eric.christensen.1@gmail.com

The presence of a snowpack has the effect of making the urban and rural environments resemble each other more closely. However,“Dirty” urban conditions, spreading of abrasives and snow relocation practices quickly modify urban snow’s local properties (i.e. increasing the density, decreasing the albedo and redistributing the depth and the areal coverage). The temporal evolution of snow properties varies spatially at scales ranging from individual streets up to that of the entire city. Previous urban studies performed in other northern cities have indicated these trends but the lack of modern snow data of this kind for Montreal and the specificity of observations from any given city to where they were taken due to differing climates and management practices prescribed a need to mount a snow measurement campaign in Montreal. This presentation will discuss the urban snowcover dataset collected as part of the Environmental Prediction in Canadian Cities (EPiCC) network in Montreal, QC, Canada and the use of this data to validate the snow submodel contained in the Interactions between Soil, Biosphere and Atmosphere (ISBA) land surface scheme. Our observations focused on a densely populated urban residential area and a suburban, single-family-dwelling area of Montreal. Depth, density and snow water equivalent were modelled in nine types of snow cover for the 2007-2008 and 2008-2009 winter seasons. Large spatial variations in snow density and depth were observed over very short distances across boundaries between snow cover types. Once snow had been displaced, the temporal evolution of bulk properties such as depth and density occurred slowly. However, albedo was observed to vary rapidly between snowfalls. Model output for 2007-2008 shows good agreement with SWE and depth observations and poor agreement with density measurements.

4D08.5 ID:3431 16:30

Off-line Numerical Weather Prediction over Montreal with the Canadian urban modeling system

Sylvie Leroyer [1], *Stéphane Bélair* [1], *Jocelyn Mailhot* [1], *Ian Strachan* [2]
[1] Environment Canada
[2] McGill
Contact: sylvie.leroyer@ec.gc.ca

One of the objectives of the Environmental Prediction in Canadian Cities (EPiCC) project is to prepare a version of the Town Energy Balance (TEB) urban model

optimized for Canadian cities and ready for implementation in the numerical weather prediction systems operational at the Meteorological Service of Canada (MSC). The present study focuses on the urban component of the off-line modeling systems developed at MSC. Two-dimensional simulations are run over the Montreal metropolitan area during the whole summer 2008 using a land-use/land-cover classification with 12 urban classes and using the operational regional model outputs as meteorological forcing. Taking advantage of the surface measurement sites deployed during EPiCC (at urban, suburban and rural sites), the results are first compared locally against observations of the surface energy budgets, air temperature and humidity. The benefits of using the off-line modeling system are evaluated by comparing results obtained with MSC's 15-km regional operational model. A second verification step is to compare model outputs with radiative surface temperature maps retrieved from satellite images. The ability of the off-line modeling system to reproduce the observed urban heat island is analyzed based on these two types of observations. The main interest of this system is to improve prediction of surface and near-surface meteorology affecting inhabitants of the major Canadian cities, especially during summer heat waves. This new tool is also suitable to help the decision makers to develop urban planning strategies, by testing the influence of the materials and of the arrangement of new districts on human comfort and energy consumption.

4D08.6 ID:3506 16:45

Urban boundary layer observations with Ceilometer and Lidar during EPiCC

Ian Mckendry , *Derek Van Der Kamp*
UBC
Contact: ian@geog.ubc.ca

A Vaisala CL31 Ceilometer was deployed in urban Vancouver as part of EPiCC in order to diagnose Mixed Layer depths. Aerosol backscatter measurements from the ceilometer are compared directly with tethersonde measurements as well as a collocated 532/1064 nm lidar in order to validate the CL31 for remote sensing of vertical aerosol structure. The cases examined include a significant aerosol event (biomass burning), which by virtue of its vertical extent, provides a robust measure of the vertical range of the ceilometer for aerosol applications. A second case is presented when the instruments were separated in order to illustrate the utility of a network of such instruments for elucidating spatial patterns in aerosol distribution and the advection of elevated pollutant layers. When co-located, the instruments show remarkable agreement and indicate that the CL31 can detect aerosol layers up to 3000 m AGL in ideal conditions (at night and with high aerosol concentrations as found in biomass burning or dust plumes). When separated, multiple instruments provide an opportunity to examine advection of pollutant layers as well as their evolution. This suggests that installation of a ceilometer network would provide a cost-effective means of examining three- dimensional aspects of regional air quality as well as distinguishing between regional and local sources of pollution. Finally, 26 months

of continuous ceilometer data was used to estimate the convective 7 mixed layer height (MLH) for 710 days by identifying strong backscatter gradients associated within the entrainment zone. To accomplish this, two mixed-layer height algorithms were assessed. The results of this Mixed Layer climatology are presented.

Coastal Oceanography and Inland Waters (Part 3) / Océanographie côtière et les eaux intérieures (Partie 3)

Room / Endroit (Panorama), Chair / Président (Guoqi Han), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D09.1 ID:3564 15:30

Examination of Circulation and Associated Seasonal Variability in the Pearl River Estuary of China Using a Nested-Grid Coastal Ocean Circulation Model

Jinyu Sheng [1], *Liqun Tang* [2]
[1] Department of Oceanography, Dalhousie University
[2] Department of Sediment Research, China Institute of Water Resources and Hydropower Research, Beij
Contact: jinyu.sheng@dal.ca

Circulation and hydrographic distributions in the Pearl River Estuary (PRE) in South China's Guangdong Province have significant temporal and spatial variability, in response of various forcing mechanisms operating over the region, including buoyancy forcing associated with freshwater runoff from the Pearl River, tides, local wind forcing, and remotely-generated coastal currents. The Pearl River is the largest river system in Southern China and the third largest river after the Yangtze and Yellow Rivers in China, with an annual mean discharge of ~340 cubic km. A three-level nested-grid coastal ocean modeling system based on the Princeton Ocean Model is used in simulating circulation in the PRE. The modeling system has three downscaling subcomponents: a coarse-resolution outer model for China Seas from Bohai Sea to the northern South China Sea; an intermediate-resolution middle model for coastal waters over the northern shelf of the South China Sea; and a fine-resolution inner model for the PRE and adjacent waters. The nested-grid system is forced by tides, meteorological forcing and buoyancy forcing associated with freshwater runoff from the Pearl River. Model results during a three-year period of 1993-95 are used in this study in examining circulation and estuarine plumes during the dry (December-March) and wet (May to August) seasons in the PRE. During the dry

season, due mainly to the combination of relatively low discharge from the Pearl River and persistent southwestward coastal currents over the inner shelf of the northern South China Sea, the estuarine plume is constrained over shallow waters close to the western coast of the PRE, and circulation over other areas of the PRE is mainly affected by tides and (local and non-local) wind forcing. In the wet season, due to large discharge from the Pearl River and highly variable currents over the inner shelf of the northern South China Sea, the estuarine plume extends significantly offshore. During the wet season, the river discharge and tides are the main driving for circulation and salinity distributions inside the PRE, and tides and wind forcing are the main driving forcing in the deep waters off the PRE.

4D09.2 ID:3780 15:45

Hydrodynamic modelling of seiches and Kelvin, Poincare and Rossby waves in Lake Ontario.

Leon Boegman [1], *Ram Yerubandi* [2]
[1] Department of Civil Engineering, Queen's University
[2] National Water Research Institute, Environment Canada
Contact: leon.boegman@civil.queensu.ca

A three-dimensional hydrostatic Reynolds averaged Navier Stokes equation model (ELCOM) has been applied to simulate the ice-free hydrodynamics of Lake Ontario during 2006. The model is compared to field observations to assess its ability to reproduce the fundamental physical processes driving hydrodynamics. The model correctly simulates the seasonal stratification, surface seiches and internal Poincaré waves without adjustment. Scaling of inflows is required to reproduce water levels. Surface topographic Rossby and internal Kelvin waves are simulated; however, these motions are under-resolved with the 2 km horizontal grid used in this study.

4D09.3 ID:3343 16:00

Inter-comparison of four hydrodynamic models for Lake Ontario

Frederic Dupont [1], *Anning Huang* [1], *Ram Yerubandi* [1], *Vincent Fortin* [1], *Youyu Lu* [2]
[1] Environment Canada
[2] DFO
Contact: frederic.dupont@dal.ca

As part of an ongoing project on coupling three dimensional lake models with GEM-LAM, an intercomparison of four hydrodynamic models, namely, Princeton Ocean Model (POM), Canadian version of Diecast (CANDIE), Estuary Lake Coastal Ocean Model (ELCOM)and Nucleus for European Modelling of the Ocean (NEMO) has been conducted on Lake Ontario over a period of six months in 2006. During this period buoys measuring surface meteorological forcing, fixed

temperarature and ADCPs were deployed in the lake. All the models provided major characteristics of the flow and thermal structure in the lake. NEMO3.2 with more proper advection and turbulence schemes provided comparable performance as other models. Further runs with NEMO using the CMC analysis were performed over a full year, thus covering the ice season using the ice modules LIM2 and LIM3. Results of the ice period will be compared to CMC analysis.

4D09.4 ID:3844 16:15

The effect of short-term variability on productivity and organic flux in a coastal sea

Sophia Johannessen , *Robie Macdonald* , *Cynthia Wright*
Fisheries and Oceans Canada, Institute of Ocean Sciences
Contact: sophia.johannessen@dfo-mpo.gc.ca

Wind and rainstorms, tidal cycles and changes in river discharge all affect productivity in coastal waters. Moored instrument arrays and sediment traps can monitor changes in water properties and organic flux continuously and with time resolution of only a few days. We present a year of sediment trap data, including particle flux and organic matter composition, in combination with electronic records of temperature, salinity, fluorescence, turbidity, current and tidal height from two moorings in the Strait of Georgia, British Columbia. These data are interpreted in the context of local meteorological and river discharge records to characterize the water column effects of short-term events, including a wind storm at the beginning of 2009, which appears to have set up conditions at 50 m that lasted for a few months. The seasonal pattern in the fraction of bloom- and non-bloom-type organic matter has been determined from measurements of stable carbon and nitrogen isotopes in the sinking material. A single spring bloom in March, 2009, is reflected in the fluorescence record at each site, and this can be related to the composition of the organic material deposited at that time.

4D09.5 ID:3357 16:30

Observations and Modelling of physical processes in Great Bear Lake

Anning Huang [1], *Ram Rao Yerubandi* [1], *William Schertizer* [1], *Normand Bussières* [2]
[1] Environment Canada/NWRI
[2] Environment Canada
Contact: ram.yerubandi@ec.gc.ca

Polar lakes are highly sensitive to changes in the climate. Some of the largest increases in the air temperature anywhere in the world have been observed in the Mackenzie Basin. As part of Environment Canada’s contribution to the International Polar Year (IPY), the impact of warming on the thermal characteristics of the Great Bear Lake is studied. During the summers of 2008 and 2009, time series observations of meteorological, hydrological and physical

limnological parameters were obtained in the lake to characterize the thermal regime in the lake. Surface heat flux components are computed from the meteorological measurements over the lake. These observations and the forecasted forcing from a regional version of the Canadian operational Global Environmental Multi-scale (GEM) model are used to simulate the ice-free hydrodynamics in the Great Bear Lake using a high-resolution, three-dimensional hydrodynamic model, namely, Princeton Ocean Model (POM). The model results of surface and sub-surface temperatures are first compared with satellite and field measurements. The model simulates weak stratification and predicts mean cyclonic circulation reasonably well. By using POM we also studied the thermal response of the lake under warmer climate. We use Canadian Regional Climate Model (CRCM) scenarios for the base climate (1970-2000) and future warmer climate (2040-2070) to carry out this analysis. In this paper, we describe preliminary results of observed and modelled surface temperature, thermal structure and circulation in the Great Bear Lake.

4D09.6 ID:4015 **16:45**

Model study of circulation and hydrography structure in Trinity Bay and Conception Bay, Newfoundland

Zhaoshi Lu [1], *Guoqi Han* [2], *Brad De Young* [1]
[1] Memorial University of Newfoundland
[2] Fisheries and Oceans Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

The Finite-Volume Coastal Ocean Model (FVCOM) is used to simulate the ocean circulation, temperature and salinity in Trinity and Conception Bays in Newfoundland. The primary goal is to hindcast the dynamics of the tide-, wind-, and buoyancy-induced flows in this coastal ocean. Thus we focus on time scales from daily to seasonal. Preliminary results of tides, currents, temperature and salinity will be presented and compared with observations.

Operational sea-ice analysis and prediction (Part 3) / Analyse opérationnelle et prévision des glaces de mer (Partie 3)

Room / Endroit (Pinnacle), Chair / Président (Thomas Carrieres), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D10.1 ID:3423 **15:30**

Sea-ice in a coupled climate prediction system

Gregory Flato , *Slava Kharin*
Canadian Centre for Climate Modelling and Analysis
Contact: greg.flato@ec.gc.ca

The Canadian Centre for Climate Modelling and Analysis has been developing a fully-coupled climate prediction system, based on an existing global climate model. The system makes use of observational data to initialize the atmosphere, ocean, land surface and sea ice, and is then used to produce ensemble forecasts out to 12 month leads. A large suite of historical forecasts have been undertaken to allow quantitative evaluation of the model's predictive skill. Here we provide some initial results on the system's ability to predict sea-ice concentration anomalies in the Arctic. The focus will be on predictions for the first month and the first season of the forecast, and the results will be discussed in the context of predictive skill at lower latitude climate quantities.

4D10.2 ID:3841 15:45

An Operational Sea Ice Analysis for North America using 3D-Var

Paul Pestieau [1], *Alain Caya* [2], *Mark Buehner* [2], *Tom Carrieres* [1]
[1] CIS, Environment Canada
[2] MRD, Environment Canada
Contact: paul.pestieau@ec.gc.ca

A 3D-Var method is used to assimilate ice concentrations retrieved from passive microwave (AMSR-E and SSM/I) and from the Canadian Ice Service (CIS) charts. CIS Operations requires a domain covering all North American (NA) waters up to the North Pole at 5km resolution and running 4 times a day. Several solutions are shown to overcome problems with passive microwave data retrieved from surface melting ice. The objective is to have this NA analysis produced operationally at the Canadian Meteorological Center (CMC) by the spring of 2010. An automated ice edge product for Davis Strait will be the first application for Operations at CIS. Verification is presented including evaluations from CIS forecasters. The analysis is also compared to the current CMC ice analysis as future work includes producing a global ice analysis using the 3D-Var method for Numerical Weather Prediction at CMC.

4D10.3 ID:3529 16:00

Three-Dimensional Variational Data Assimilation in the Gulf of St. Lawrence coupled Ice-Ocean Model

Alain Caya
Environnement Canada
Contact: alain.caya@ec.gc.ca

A three-dimensional variational data assimilation (3D-Var) system has been developed to provide analyses of the ice-ocean state for a coupled atmosphere-ice-ocean model in the area of the Gulf of St. Lawrence. The study focuses on

the impact of sea-ice data assimilation on the prediction of sea-ice condition. Data assimilation experiments, using various configurations of the 3D-Var, are conducted over a 4-month period during the winter of 2007. The analysis system assimilates RADARSAT image analyses produced by the Canadian Ice Service, and these provide partial ice fractions of dominant ice thickness categories. The impact of additionally assimilating total ice concentration retrievals using the NASA TEAM 2 algorithm from passive microwave observations is studied. To obtain ocean state analysis increments consistent with the sea ice analysis increments and in preparation to assimilating sea surface temperature data, an ensemble estimate of the background-error covariance matrix is used and preliminary results are shown.

4D10.4 ID:3435 16:15

Sea Ice Data Assimilation for the Canadian East Coast.

Anna Katavouta , *Paul Myers*
University of Alberta
Contact: a.katavouta@gmail.com

The ocean model NEMO coupled with the ice model LIM2, in a North Atlantic/Nordic sea configuration, is used to simulate the sea ice for the Canadian east coast (Labrador and Newfoundland shelves). The simulation covers 4 years, from 2002 to 2005. The sea ice fields produced by a free run of the ocean/sea ice coupled model are not realistic. We explored the impact of sea ice concentration data assimilation in the model forecast. First a simple ice concentration nudging is executed, based on the differences between the sea ice fields produced by the Canadian Ice Service and the results of the model's free run. This experiment reveals that by altering "manually" the sea ice concentration properties we correct the sea ice concentration but shows that corrections are needed to the ice thickness and the upper ocean salinity and temperature. We then apply a 1-D data assimilation scheme with corrections to the ice thickness, the underlying salinity and temperature. The corrections are based on the correlations between the sea ice concentration and the other relevant fields. We base the correlations on a ten member ensemble with random perturbation in the forcing fields. The perturbations are produced by decomposing each forcing field using Empirical orthogonal functions (EOFs) and then randomly weighting and combining the first fifty leading EOFs.

4D10.5 ID:3742 16:30

Direct assimilation of AMSR-E and AVHRR data for the purpose of estimating sea-ice concentration

Andrea Scott [1], *Mark Buehner* [1], *Tom Carrieres* [2]
[1] Meteorological Research Division, Environment Canada
[2] Marine and Ice Services Division, Environment Canada
Contact: andrea.scott@ec.gc.ca

Ice forecasting is typically done by assimilating a retrieved ice concentration. However, ice concentration retrievals are known to suffer from weather contamination, and are limited in resolution to the coarsest channel used in the retrieval. Instead of following this methodology, our approach is to assimilate satellite data directly within a three-dimensional variational data assimilation system (3D-Var). To do this we need to develop forward models which map the state space to the observation space. Two different types of forward models corresponding to two different types of observations will be described in this talk. The first type of observation is passive microwave brightness temperatures from AMSR-E. In this case a simple radiative transfer model (RTM) is used as the forward model. This allows brightness temperatures for all channels to be modeled as a function of the total ice concentration, surface wind speed, sea surface temperature, ice temperature, vertically integrated water vapor and integrated cloud liquid water. The second type of observation is albedos and brightness temperatures from a visible/infrared sensor, AVHRR. Here, an empirical model based on tie-points for ice, open water, and cloudy conditions, is used as the forward model. In this case the observation error is a function of the state vector. The methodology used to assimilate both types of observations will be described and results will be shown for an area in the Labrador Sea.

4D10.6 ID:3632 16:45

A new approach for sea-ice data assimilation: Estimation of displacement errors for ice floes and edges

Mark Buehner , *Michael Ross*
Environment Canada
Contact: Mark.Buehner@ec.gc.ca

The theory and recent results from applying a new approach to sea-ice data assimilation will be presented. Instead of assimilating satellite observations to directly estimate variables that describe the sea ice conditions (e.g., ice concentration, thickness), the same data are assimilated to estimate the error in the displacement of coherent features (e.g., ice floes, edges) already present in the background state. It will be shown how, relative to the conventional approach, this new approach can more effectively extrapolate information spatially from the observations while maintaining sharp spatial gradients. The general approach of estimating displacement errors may also be appropriate for several other data assimilation applications in which displacement (or phase) errors occur in fields that have coherent features with sharp spatial gradients. Examples of such applications will be briefly discussed.

The Vancouver 2010 Olympic and Paralympic Games / Les Jeux olympiques et paralympiques d'hiver de Vancouver 2010

Room / Endroit (Pl. de Ville Conf. 1), Chair / Président (G.A. Isaac), Date (04/06/2010), Time / Heure (15:30 - 17:00)

4D14.1 ID:4072 INVITED/INVITÉ 15:30

Science and Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) – First Results from Field Phase Jan-Mar, 2010

George Isaac [1], *Paul Joe, Monica Bailey, Faisal Boudala, Edwin Campos, Stewart Cober* [1], *Ismail Gultepe, Laura Huang* [1], *Trevor Smith, Bertrand Denis, Chris Doyle* [2], *Jocelyn Mailhot, Stéphane Bélair, Jason Milbrandt* [3], *Douglas Forsyth* [4], *Richard Carpenter* [5], *Thomas Haiden* [6], *Ron Stewart* [7], *Roy Rasmussen* [8], *Donghai Wang* [9]

(Presented by *G.a. Isaac*)

[1] Cloud Physics and Severe Weather Research Section, Environment Canada
[2] MSC Environment Canada
[3] Recherche en prévision numérique, Environment Canada
[4] National Severe Storms Laboratory, Norman, Oklahoma, USA
[5] Weather Decision Technologies
[6] Central Institute for Meteorology and Geodynamics (ZAMG), Austria
[7] Department of Environment and Geography, University of Manitoba
[8] National Center for Atmospheric Research, Colorado, USA
[9] Chinese Academy of Meteorological Science, China

Contact: george.isaac@ec.gc.ca

The field phase of a new World Weather Research Project (WWRP) of the World Meteorological Organization (WMO) called the Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) was conducted in BC during Jan-Mar 2010. Short term weather forecasting or Nowcasting, which concentrates on 0-6 hr predictions, had been the focus of several WWRP projects associated with the Sydney 2000 and the Beijing (2008) Summer Olympic Games. SNOW–V10 is first similar project to look at winter weather. It is designed to produce better techniques to nowcast cloud, fog, visibility, precipitation type and amount, and wind and turbulence in mountainous terrain. This will be done by using state-of-the-art numerical modeling systems, new on-site surface and remote sensing observing systems, as well as Nowcasting systems which blend observations and model predictions into improved short term forecasts. Preliminary results of the field work are now available. This paper will give a short summary of some of the results, introduce some of the Nowcast products developed, and highlight some interesting case studies. Initial reactions from the forecasters who were

using the products in real time will also be presented.

4D14.2 ID:4105 INVITED/INVITÉ 15:45

The Utility of the SNOW-V10 Observing Network for Winter Complex Terrain Nowcasting

Paul Joe [1], *George Isaac* [2], *Stewart Cober* [1], *Ismail Gultepe* [1], *Chris Doyle* [3], *Trevor Smith* [3], *Roy Rasmussen* [4], *Faisal Boudala* [1], *Edwin Campos* [1]
[1] Science and Technology Branch
[2] science and tecScience and Technology Branchhnology branch
[3] Meteorological Service of Canada
[4] National Center for Atmospheric Research
Contact: paul.joe@ec.gc.ca

A network of in-situ and remote sensing observation sites were establish along the Whistler Mountain slope to support the nowcasting service provided by Environment Canada. As little is known about the weather on the temporal and spatial scale required to meet the forecast requirements, a supporting observation and science program was established to study precipitation, low visibility and strong winds. Most of the instruments are non-standard, from an operational monitoring perspective, but proved to be used extensively by the forecasters. These include temperature, humidity, precipitation and visibility data reported at one minute intervals. Winds were reported at 1 second intervals. The spatial nowcast requirements for the Olympic venues on Whistler Mountain were of the order of 100 meters in the vertical which translates into 300-400 meters in the horizontal. For example, the rain-snow line was critical to decision-making for running the downhill race and it significantly mattered whether the course was in rain or in snow. The 1 minute intensity of precipitation and visibility were important for decision making. The network components, the nowcast requirements, the validation analysis and product examples will be described to demonstrate the utility of the network.

4D14.3 ID:4084 INVITED/INVITÉ 16:00

The high-resolution numerical weather prediction system for the 2010 Vancouver Olympics

Jason Milbrandt [1], *Jocelyn Mailhot* [1], *Bertrand Denis* [2], *Andre Giguere* [2], *Ron McTaggart-Cowan* [1], *Anna Glazer* [1], *Neil Mclennan* [2], *Amin Erfani* [2], *George Isaac* [1], *Paul Joe* [1]
[1] Meteorological Research Division
[2] Canadian Meteorological Centre
Contact: jason.milbrandt@ec.gc.ca

The 2010 Winter Olympic and Paralympic Games took place in British Columbia, Canada during February and March, 2010. In order to provide the best possible weather prediction guidance using state-of-the-art science and technology, Environment Canada ran an experimental numerical prediction system for these

special events. The system included high-resolution (2.5-km and 1-km) limited-area model (LAM) forecast grids with the Global Environmental Multiscale (GEM) numerical weather prediction model for domains over the Vancouver-Whistler region, which were run operationally twice daily by the Canadian Meteorological Centre (CMC). This special model configuration used improved geophysical fields, new radiation and cloud microphysics schemes, and the latest dynamical core version of the GEM model.

An overview of the experimental GEM-LAM forecast system will be presented. Comparisons will be made between the forecast fields from the 2.5-km and 1-km grids as well from the standard 15-km regional GEM model. It will be shown that with the use of increased model resolution and sophisticated physical parameterizations, there is a distinct increased forecast value for this region of complex terrain.

4D14.4 ID:3342 INVITED/INVITÉ 16:15

Continuous Thermodynamic Profiling for Olympic Weather Prediction

Randolph Ware [1], *Domenico Cimini* [2], *Steve Albers* [3], *Steven Koch* [4], *Edwin Campos* [5], *Paul Joe* [5], *Stewart Cober* [5]

[1] Radiometrics Corporation, NCAR, CIRES
[2] CETEMPS, University of L'Aquila, Italy
[3] NOAA ESRL GSD, CIRA
[4] NOAA ESRL GSD
[5] Environment Canada
Contact: ware@radiometrics.com

Environment Canada operated a Thermodynamic Profiler (microwave radiometer) at the base of the Whistler Creekside Gondola during the Vancouver 2010 Winter Olympic and Paralympic Games. Traditional forecast tools and indices generated from continuous radiometric temperature, humidity and liquid profiles were used to enhance Olympic Nowcasting and short-term local weather prediction. Radiometric profiles were retrieved using traditional neural network methods and innovative 1DVAR (one-dimensional variational analysis) retrieval methods. The 1DVAR method combines observed and forward-modeled local analysis brightness temperatures with covariance matrices to optimize retrieval accuracy. The analysis contributes primarily to retrieval accuracy in the upper troposphere, and the radiometer to the boundary layer and lower troposphere. Comparison of neural network and 1DVAR retrievals with radiosonde soundings, and impacts of continuous thermodynamic profiles on Olympic Nowcasting and short-term weather prediction will be presented.

4D14.5 ID:4078 16:30

Visibility parameterizations: Its relation to precip type and its variability along a mountain slope during SNOW-V10

I. Gultepe [1], *J. Milbrandt* [1], *G. A. Isaac* [1], *R. Rasmussen* [2], *F. Boudala* [1], *P. Joe* [1]
[1] Environment Canada, Toronto, Ontario, Canada
[2] NCAR, Boulder Colorado, USA
Contact: ismail.gultepe@ec.gc.ca

The goal of this work is to study parameterizations of visibility (Vis), its variability, and its relation to precipitation type observed during the SNOW-V10 nowcasting project. This project took place in the Vancouver-Whistler region during the 2010 Winter Olympics and Paralympics for the period of February to March 2010. Observations of Vis from the FD12P, Sentry, and HSS Vis sensors, and precipitation rates (PR) and types from FD12P, GEONOR, LPM, OTT Parsivel, and TPS sensors collected at four locations along the Whistler mountain slope will be used in the analysis. During SNOW-V10, Vis, PR, and precipitation types from the GEM and GEM-LAM models were predicted and compared to observations for nowcasting applications. Results suggest that: 1) Vis parameterization depends on precipitation type and its density, 2) uncertainty in Vis based on observations can be as high as 30%, and 3) vertical variability in Vis in the mountainous regions over 1000 m height can be as much as 100%. It is concluded that if the models can accurately predict relative humidity (RH), liquid water content (LWC), ice water content (IWC), and precipitation rate (PR), as well as the particle number concentrations, model-based Vis can be within the ±25% of the observed values.

4D14.6 ID:4006 16:45

The Meteorological Conditions During a SNOW-V10 Graupel Event

Teresa Fisico [1], *Ismail Gultepe* [2], *Alex Laplante* [3], *Ronald Stewart* [1], *Paul Joe* [2], *George Isaac* [2], *Jason Milbrandt* [4]
[1] Department of Environment and Geography, University of Manitoba
[2] Cloud Physics and Severe Weather Research Section, Science and Technology Branch, Environment Canada
[3] McGill University
[4] Meteorological Research Division, Environment Canada, Dorval, Quebec
Contact: fisico@cc.umanitoba.ca

The objective of this study is to understand the meteorological conditions of a graupel (snow pellets) event that occurred during the SNOW-V10 field project at the Roundhouse (RND) site on Jan 21 2010. Winter precipitation is extremely difficult to measure because of the sensitivity of optical sensors to particle shape and density. Models generally use a crude approximation for precipitation type that occurs at cold temperatures. A better understanding of the formation and environment associated with winter precipitation can lead to improved numerical representations, and ultimately to better predictions based on model simulations. In association with SNOW-V10, high-resolution photographs (~85 microns/pixel) of precipitation were taken at the RND site on Whistler Mountain from January 11 to 23, 2010, alongside detailed automated surface meteorological and particle observations, as well as the profiles of radar and the profiling microwave

radiometer (MWR) based parameters. Precipitation from intermittent snow showers was photographed between 1:00 pm and 2:30 pm PST on January 21 at about five-minute intervals. Images showed an evolution of dendrites and crystal fragments to instances of dendrites with an increasing degree of riming and aggregates. By the end of the event, riming became extensive and graupel was occurring. In the presentation, preliminary results related to a combination of microwave rain radar (MRR), profiling MWR, surface observations, and photographic analysis will be shown and a description and categorization of the evolving atmospheric column above the RND site will be summarized.

Author Index / Index des auteurs

Key to the codes: The first two characters represent the session that the paper or poster is in, as per the Week at a Glance. The next two numbers stand for the room where the session takes place, also as indicated in the Week at a Glance. For papers, the number following the decimal point indicates the order of the paper in the session. For posters, the four digits immediately following the hyphen represent the theme within the session, and the number following the decimal point indicates the placement of the poster in its theme.

Note: Bold-faced codes identify papers or posters that are presented by the corresponding individual.

Clé d'interprétation des codes: Les deux premiers caractères représentent le bloc de sessions tel qu'identifié dans l'Aperçu de la semaine. Les deux prochains chiffres forment le numéro de la pièce où se donne la session, aussi indiqué dans l'Aperçu de la semaine. Pour les présentations, le chiffre qui suit le point indique l'ordre de la présentation dans la session. Pour les affiches, les quatre chiffres qui suivent le tiret indiquent le thème de la session et le chiffre indique la position de l'affiche dans le thème.

À noter: Un code en caractères gras indique que le nom correspondant donne la présentation orale ou présente l'affiche.

MAY 31 – JUNE 4 / 31 MAI – 4 JUIN

2010

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44th Annual CMOS Congress / 36th Annual Scientific Meeting of CGU / 3rd Joint CMOS-CGU Congress
44e Congrès annuel de la SCMO / 36e Rencontre scientifique annuelle de l'UGC / 3e Congrès organisé conjointement par la SCMO et l'UGC

Canadian Meteorological and Oceanographic Society / La Société canadienne de météorologie et d'océanographie
Canadian Geophysical Union / Union géophysique canadienne

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Commanditaires

De la part de tous les délégués, la Société canadienne de météorologie et d'océanographie et l'Union géophysique canadienne souhaitent reconnaître les principaux commanditaires pour leur appui et contribution à notre 3ème Congrès conjoint SCMO-CGU 2010 (44ème Congrès annuel de la SCMO et 36ème Rencontre scientifique annuelle de l'UGC).

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La Société canadienne de météorologie et d’océanographie (SCMO)
L’Union géophysique canadienne (UGC)

44ième Congrès de la SCMO
36ième Rencontre annuelle de l’UGC
Ottawa 2010

31 mai - 4 juin 2010

La Terre
l’air et
l’eau

Notre Avenir

Éditeur : Mario Ouellet

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NOTES

Accès à l'internet: L'accès à l'internet sans fil sera disponible durant le Congrès. Le code d'accès est CMOSCGU (en majuscules). Un nom d'usager n'est pas requis.

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Mot de bienvenue du Ministre de l'environnent Jim Prentice

J’ai le plaisir de souhaiter la bienvenue à tous les délégués au 44e Congrès annuel de la Société canadienne de météorologie et d’océanographie qui, cette année, a lieu à Ottawa.

Le thème de cette année, « La Terre, l’air et l’eau : notre avenir », reflète très bien les priorités actuelles d’Environnement Canada et du pays tout entier. J’aime ce thème, car il véhicule un message simple : si nous consacrons du temps et des efforts à l’amélioration et à la préservation de la Terre, de l’air et de l’eau, ce sont les générations canadiennes de demain qui en récolteront les fruits.

Voilà pourquoi je suis très fier des efforts que déploient les centaines de météorologistes, d’ingénieurs, de climatologues, de techniciens, de scientifiques et de chercheurs canadiens dans les secteurs de la météorologie et de l’océanographie. Leurs efforts, combinés à ceux de nos partenaires du secteur privé, ont des répercussions positives sur notre quotidien.

À Environnement Canada, nous cherchons continuellement à fournir à la population canadienne des prévisions météorologiques fiables et précises. Les prévisions et les avertissements aident les citoyens à mieux planifier leur quotidien ainsi qu’à protéger leur famille et leurs biens en cas de temps violent.

Le Ministère compte dans ses rangs certains des experts en prévisions de renommée mondiale et utilise de l’équipement de prévision à la fine pointe de la technologie. L’engagement de ces experts et les services qu’ils offrent à tous les Canadiens sont extrêmement importants, non seulement pour assurer leur sécurité, mais aussi pour protéger le bien-être environnemental et économique du pays.

D’un océan à l’autre, les Canadiens profitent de l’expertise de renommée mondiale du Canada en matière de prévisions environnementales ainsi que du dévouement des météorologues et des océanographes présents à ce Congrès.

J’espère que vos discussions stimuleront le débat et renforceront les liens afin de soutenir l’engagement du Canada à fournir à la population canadienne des prévisions environnementales qui, non seulement respectent, mais dépassent les normes d’excellence établies au pays.

Le ministre de l’Environnement,
Jim Prentice

Mot de bienvenue du Ministre des ressources naturelles Christian Paradis

Mes salutations les plus chaleureuses au comité organisateur et à vous tous qui êtes ici présents à ce Congrès, organisé conjointement par la Société canadienne de météorologie et d'océanographie et par l'Union géophysique canadienne!

Comme vos deux importantes organisations, le gouvernement du Canada joue depuis longtemps un rôle dynamique dans les secteurs d'activité représentés à ce Congrès conjoint de la SCMO et de l'UGC. Nous sommes donc comme vous concernés de près par le thème de cette conférence de cinq jours qui se déroule à Ottawa : La Terre, l'air et l'eau : notre avenir.

Une bonne partie du travail de Ressources naturelles Canada (RNCan) porte sur les aspects les plus dynamiques des changements inhérents à notre planète. Dans le cadre des projets NEPTUNE et VENUS, deux observatoires sous-marins câblés, parmi les plus avancés au monde, des scientifiques de la Commission géologique du Canada (CGC) de RNCan aident les partenaires des projets à surveiller les activités sismiques et à étudier la stabilité de la pente au large des côtes de la Colombie-Britannique. En Haïti, la CGC a récemment installé le premier réseau de surveillance sismique du pays.

Les géosciences aident à définir le Canada, ses entités physiques et ses richesses pétrolières, gazières et minérales. Le gouvernement du Canada a dernièrement renouvelé l'Initiative géoscientifique ciblée de RNCan, qui, avec le programme Géocartographie de l'énergie et des minéraux, fournit à l'industrie, aux pouvoirs publics et à d'autres intéressés de l'information géoscientifique précieuse pour accroître l'efficacité de la prospection.

Notre savoir-faire est mis à profit pour la collecte et l'interprétation des données scientifiques devant étayer le dossier que le Canada présentera à la Commission des limites du plateau continental des Nations Unies. De plus, nous accélérons nos travaux en géosciences des eaux souterraines en vue de terminer la cartographie des aquifères régionaux clés d'ici 2025.

Ces activités, et bien d'autres, démontrent comment la connaissance de la masse continentale canadienne et des processus qui l'affectent peut contribuer à améliorer notre qualité de vie.

Laissez-moi vous assurer que notre gouvernement est bien au courant des contributions scientifiques de votre affiliation à notre nation. Au nom du gouvernement du Canada, je vous souhaite un congrès des plus fructueux.

L'honorable Christian Paradis, C.P., député
Ministre des Ressources naturelles

Mot de bienvenue de la Ministre des pêches et des océans
Gail Shea

J'ai l'honneur de vous souhaiter la bienvenue dans la capitale nationale à l'occasion de votre troisième congrès conjoint annuel.

À Pêches et Océans Canada, nous partageons votre engagement envers la conservation, la protection et le développement durable des océans. Comme l'évoque le thème de votre congrès cette année, nous comprenons les liens qui unissent la terre, l'air, l'eau et notre avenir.

Les océans du Canada font partie intégrante de notre identité nationale. Ils sont au cœur de la vie d'un grand nombre de nos collectivités, et sont considérés comme une ressource essentielle par tous les Canadiens.

Couvrant 71 pour 100 de la surface de la Terre, les océans sont également importants pour la vie sur notre planète. Ils fournissent une partie de la nourriture que nous mangeons et aident à purifier l'eau que nous buvons. Ils génèrent une bonne partie de l'oxygène que nous respirons et contribuent à réguler notre climat en absorbant, en stockant et en distribuant la chaleur. Les océans stimulent également l'économie mondiale, créent des emplois et soutiennent les collectivités.

Pour protéger les océans du Canada et comprendre notre climat, nous avons besoin d'une approche de gestion intégrée mettant à contribution plusieurs disciplines et plusieurs paliers de gouvernement. Le Congrès SCMO-UGC 2010 est une excellente occasion de partager les connaissances entre les différentes disciplines et les leaders du gouvernement.

Le gouvernement du Canada travaille avec ses partenaires à faire en sorte que les générations futures de Canadiens héritent d'océans et de ressources océaniques non contaminées et que notre utilisation collective de ces ressources soit durable.

Je vous souhaite un congrès très fructueux et j'espère que vous aurez un peu de temps pour visiter la région de la capitale nationale.

L'honorable Gail Shea, C.P., députée
Ministre des Pêches et des Océans

Mot de bienvenue du Premier ministre de l'Ontario

Ontario

Premier of Ontario - Premier ministre de l'Ontario

Du 31 mai au 4 juin 2010

UN MESSAGE DU PREMIER MINISTRE DE L'ONTARIO

Au nom du gouvernement de l'Ontario, j'aimerais transmettre mes plus chaleureuses salutations à l'ensemble des participants et participantes au 3e Congrès organisé conjointement par la Société canadienne de météorologie et d'océanographie (SCMO) et l'Union Géophysique Canadienne (UGC).

Les Ontariens et les Ontariennes, et la nation tout entière, sont fiers du savoir et de l'expertise que l'on trouve au sein d'organismes tels que la SCMO et l'UGC. C'est en renforçant notre capacité scientifique que nous pouvons demeurer concurrentiels et mieux comprendre les forces qui façonnent le monde d'aujourd'hui. Je félicite les membres de ces deux organismes exceptionnels : ceux de la SCMO pour leur travail soutenu afin d'enrichir nos connaissances dans les domaines de la météorologie et de l'océanographie au Canada et ceux de l'UGC pour leur dévouement inébranlable à l'approfondissement de notre compréhension de la géophysique.

Sous le thème : *La terre, l'air et l'eau — Notre avenir*, les participants et participantes au congrès conjoint de cette année auront l'occasion d'entendre d'éminents conférenciers et conférencières, de participer à des séances traitant de sujets d'ordre scientifique allant du changement climatique au milieu arctique, et de prendre contact avec des collègues.

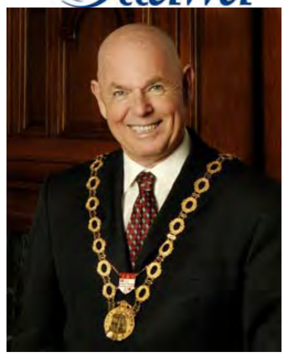
L'organisation d'un événement de ce calibre est un projet d'envergure. C'est pourquoi je tiens à remercier tous ceux et toutes celles qui ont consacré temps et énergie afin d'en assurer la tenue.

Je vous souhaite un congrès couronné de succès.

Le premier ministre de l'Ontario,

Dalton McGuinty

Mot de bienvenue du Maire d'Ottawa



Larry O'Brien
Mayor / Maire

Au nom des membres du Conseil municipal d'Ottawa, qui représentent les 900,000 résidents de la ville, je souhaite la plus cordiale bienvenue aux délégués au *3^{e} Congrès organisé conjointement par la Société canadienne de météorologie et d'océanographie (SCMO)* et *l'Union géophysique canadienne (UGC),* ainsi qu'au *44^{e} Congrès annuel de la SCMO* et à la *36^{e} Rencontre scientifique annuelle de l'UGC,* qui se déroulent au cœur de notre capitale nationale du 31 mai au 4 juin 2010.

En ma qualité de chef du Conseil, je tiens à exprimer mon appui sans réserve à la *SCMO* et à l'*UGC* pour la collaboration dont ils ont su faire preuve afin d'offrir des tribunes aux scientifiques, aux chercheurs, et aux experts dans les domaines de l'océanographie, de la météorologie et de la géophysique. Ils sont ainsi en mesure de faire du réseautage, d'échanger des idées, de participer à des sessions scientifiques ainsi que d'assister à des conférences plénières, à des ateliers et à des exposés.

Je tiens aussi à féliciter les hôtes de ces réunions, ainsi que les conférenciers, les animateurs, les collaborateurs, les commanditaires et les bénévoles pour le temps, l'énergie, l 'expertise et les ressources qu'ils ont consacrés à l'organisation de ces grands rassemblements de scientifiques d'envergure nationale et internationale.

Ayant pour thème *La Terre, l'air et l'eau : Notre avenir,* le Congrès donne à quelque 1000 délégués l'occasion d'examiner des sujets environnementaux importants, y compris les changements du climat océanique, les conditions météorologiques et le climat et leurs effets sur la santé, la qualité de l'air et l'énergie éolienne.

En tant que maire de la ville hôte, j'invite les visiteurs à découvrir les nombreux lieux municipaux d'importance historique ainsi que les trésors nationaux et les sites patrimoniaux abondants que recèle la capitale du Canada.

Je souhaite à tous les délégués des réunions des plus productives et enrichissantes.

Recevez mes salutations distinguées.

Le maire,

Larry O'Brien

110 Laurier Avenue West, Ottawa, ON K1P 1J1/110, avenue Laurier Ouest, Ottawa ON K1P 1J1
Tel/tél. : 613-580-2496 Fax/téléc. : 613-580-2509
e-mail/courriel : Larry.OBrien@ottawa.ca
Web : ottawa.ca

Mots de bienvenue de la part des sociétés et des comités

Mot de bienvenue de la part du président de la SCMO

Au nom de la SCMO, j'aimerais vous souhaiter la bienvenue au Congrès 2010 « La Terre, l'air et l'eau, NOTRE AVENIR ». Ce congrès nous donne l'occasion de communiquer nos percées scientifiques, d'observer de plus près le monde scientifique, de récompenser les collègues qui se sont distingués, de renouer avec les amis et de forger de nouvelles amitiés. Cette année, la SCMO est l'hôte du congrès organisé conjointement avec l'Union géophysique canadienne, un partenariat dont le franc succès à St. John's, en 2007, a motivé les deux sociétés à renouveler l'expérience à Ottawa, en 2010. Nous souhaitons remercier tout particulièrement John Falkingham, président du Comité des dispositions local, ainsi que Dick Stoddart et Ron Blais, coprésidents du Comité scientifique. Ces personnes dirigent plus d'une trentaine de bénévoles au sein de leurs comités, auxquels de nombreux autres s'ajouteront durant la semaine du congrès. Les travaux ont commencé avant même le dernier congrès, et bon nombre de bénévoles continueront de travailler après l'été prochain.

Nos organisateurs s'en remettent au nombre de résumés reçus pour prévoir la participation. À en juger par ce nombre cette année, les inscriptions seront nombreuses, ce qui nous permet de consacrer davantage de fonds pour financer les déplacements des étudiants au congrès.

En plus de vous inviter à assister aux présentations de rapports scientifiques et aux conférences des plénières, je vous encourage à visiter les exposants et à participer à l'assemblée générale annuelle de la SCMO. Les autres événements prévus au programme sont les dîners de remise de prix et les déjeuners-rencontres spéciaux ainsi que la conférence publique.

Je souhaite à tous que ce prochain congrès à Ottawa soit des plus stimulants et des plus productifs.

Bill Crawford
Président de la SCMO

Mot de bienvenue de la part du président de l'UGC

Bienvenue au 3e Congrès 2010 organisé conjointement par la SCMO et l'UGC « La Terre, l'air et l'eau, notre avenir ».

Ce congrès conjoint devrait connaître un franc succès et dépasser toutes les attentes! Avec plus de 800 résumés reçus et au-delà de 100 sessions techniques prévues, le Comité des dispositions local (CDL) et le Comité du programme scientifique (CPS) doivent s'acquitter d'une tâche monumentale, mais néanmoins très agréable, pour accueillir chaque personne dans le cadre de ce programme technique d'une durée de quatre jours. Nous aurons l'occasion de connaître les plus récentes percées scientifiques dans tous les secteurs des sciences géophysiques, notamment certains sujets et projets de recherche multidisciplinaires. Aux plénières et sessions techniques se grefferont des ateliers qui permettront de discuter des projets de collaboration en cours et d'assurer la planification de nouvelles initiatives. C'est à ne pas manquer!

Le congrès 2010 organisé conjointement par la SCMO et l'UGC s'inscrit dans la portée et les objectifs des Sociétés canadiennes pour les sciences géophysiques (SCSG), et ouvre la voie à la promotion et à la consolidation de leur vision et de leur mission. L'Union géophysique canadienne est fière de collaborer et de contribuer à ce congrès et d'y être bien représentée.

La SCMO et l'UGC encouragent et favorisent vivement la participation active des étudiants à tous les congrès et événements annuels, et ce congrès ne fait pas exception à la règle. De nombreux prix et bourses de voyage destinés aux étudiants sont prévus pour soutenir et parrainer nos jeunes scientifiques et chercheurs qui sont appelés à devenir le cœur et l'âme de nos sociétés de demain. Voilà pourquoi, en constatant la participation impressionnante des étudiants au congrès, le CDL a proposé récemment de porter à 20 000 $ le budget des bourses de voyage, et cette proposition a été unanimement acceptée par les présidents des deux sociétés.

En marge des sessions techniques et des ateliers, nous tiendrons aussi une conférence publique qui permettra de briser la glace, ainsi que nos assemblées générales annuelles, des déjeuners-rencontres et des dîners de remise de prix. Ces activités connexes au programme technique permettront de reconnaître les contributions et les réalisations de nos collègues et amis et favoriseront les contacts et les échanges. J'encourage aussi tous les membres de l'UGC à accueillir et à appuyer nos quatre sections, soit Hydrologie, Géodésie, terrestre et Biogéosciences, et à démontrer un esprit d'initiative et de participation.

Au plaisir de vous revoir à Ottawa à l'occasion de ce congrès stimulant, dynamique et productif!

Spiros Pagiatakis
Président de l'UGC

Mot de bienvenue du comité du programme scientifique

Au nom du comité du programme scientifique (CPS), il nous fait plaisir de vous souhaiter la bienvenue au Congrès conjoint 2010 de la SCMO-UGC. Le thème du congrès “La Terre, l’air et l’eau: Notre Avenir, et les 800 présentations orales et affichées, reflètent vraiment l’envergure, la diversité et la nature de plus en plus interdisciplinaire de la communauté scientifique des deux sociétés, incluant météorologistes, océanographes, climatologistes, géodésiens, hydrologistes, limnologistes, biogéoscientifiques, scientifiques de la terre, de la cryosphère et de l’environnement.

Le vaste champ scientifique de ce congrès est aussi démontré dans les présentations plénières d'experts canadiens et internationaux. Le programme scientifique est organisé en 10 catégories thématiques, 65 sessions spécialisées, dont quelques-unes en plusieurs parties, résultant en 119 sessions regroupant 650 présentations orales et 150 présentations affichées. Ayant à composer avec 14 sessions en parallèle durant le congrès, le CPS et les Organisateurs des sessions ont dû surmonter plusieurs problèmes de temps et d'espace pour satisfaire aux demandes. Le CPS considère les présentations affichées comme une partie intégrale du congrès et vous invite à assister à ces sessions mardi et jeudi après-midi.

Dick Stoddart

Si les étudiants sont l'avenir de nos deux sociétés, nous sommes entre bonnes mains. Les demandes de bourses étudiantes de voyage ont doublées en comparaison avec l'an dernier. Le CPS a été heureux de réagir en doublant les fonds disponibles pour les quelques 82 étudiants admissibles. De tous les résumés soumis, 240 le sont d'étudiants, ce qui représente environ 30% du programme.

Rod Blais

Nous voudrions remercier bien spécialement tous les bénévoles qui ont rendu ce congrès possible, particulièrement les membres du comité scientifique et du comité des dispositions local, et le personnel de l’administration centrale de la SCMO pour leur temps et expertise.

Nous espérons que vous allez profiter de cette excellente occasion pour faciliter les interactions et les échanges avec les experts canadiens et internationaux. Bienvenue à Ottawa.

Dick Stoddart et Rod Blais
Co-présidents, Comité du programme scientifique

Mot de bienvenue du Comité des dispositions local

Au nom du Comité des dispositions local (CDL), j'ai le plaisir de vous accueillir au 3e Congrès conjoint SCMO-UGC, au 44e Congrès de la Société canadienne de météorologie et d'océanographie (SCMO) ainsi qu'à la 36e Rencontre scientifique annuelle de l'Union géophysique canadienne (UGC). Le thème – « La Terre, l'air et l'eau : Notre avenir » – souligne les interconnexions au sein de notre environnement et la responsabilité que nous partageons afin de le comprendre en fonction de notre future prospérité.

Après toute une journée de rencontres et d'ateliers du comité de la SCMO et de l'UGC, la réception « brise-glace » qui aura lieu lundi soir à l'étage du toit-terrasse de l'hôtel Crowne Plaza marquera l'ouverture officielle du congrès. Une vue à couper le souffle d'Ottawa, de Gatineau, des rivières et des collines au-delà serviront de toile de fond pour une soirée de festivités, de jazz et de conversation amicale tandis que de vieilles amitiés seront renouées et que de nouvelles se formeront.

John Falkingham

L'activité principale du congrès commencera le mardi, et comme vous pouvez le constater grâce au programme et à leur propre message d'accueil, le Comité du programme scientifique (CPS) a préparé tout un programme.

Les activités sociales se poursuivront mercredi avec le dîner Patterson-Parsons des membres de la SCMO et un barbecue informel pour les membres de l'UGC. Les membres de la SCMO et de l'UGC pourront se rencontrer mercredi soir à l'occasion d'une réception mixte et la soirée se poursuivra avec la conférence publique du professeur Warwick F. Vincent. Cette conférence, ouverte et gratuite pour le public, s'inscrit dans la tradition de l'enseignement des sciences. J'incite tous les délégués du congrès à se joindre au public pour une présentation stimulante et intéressante.

Le jeudi, en soirée, la SCMO et l'UGC tiendront simultanément, mais séparément, leurs banquets de remise de prix. La taille des deux sociétés jointes rend impossible la tenue d'un banquet conjoint dans les locaux qui nous sont alloués cette année. Néanmoins, je souhaite sincèrement que les membres de la SCMO et de l'UGC trouvent de nombreuses occasions d'interagir les uns avec les autres. L'hôtel Crowne Plaza a l'avantage d'être situé au centre-ville d'Ottawa à proximité d'une multitude d'attractions culturelles et historiques. Faites un tour de trolleybus dans la ville ou de bateau sur le canal Rideau; visitez la Colline du Parlement, la Cour suprême, le Centre national des Arts ou l'un des nombreux musées situés de chaque côté de la rivière des Outaouais. Vous trouverez des dizaines de restaurants, de cafés et de pubs autour de l'hôtel. Arpentez le mail de la rue Sparks avec ses magasins et boutiques ou aventurez-vous au marché By pour goûter à la vie nocturne.

La préparation de ce congrès a nécessité un travail diligent de bon nombre de bénévoles au cours des deux dernières années. Il s'agit du plus important congrès organisé à ce jour par la SCMO et l'UGC. Je tiens à remercier tous les membres du CDL et des sous-comités pour leur dévouement infatigable. Pareillement, aux étudiants bénévoles et aux membres locaux de la SCMO et de l'UGC qui donnent de leur temps pour assurer le bon déroulement des activités cette semaine, un gros merci.

Le Comité des dispositions local et nos bénévoles sont à votre service cette semaine pour toute question que vous pourriez avoir. Cherchez nos vestes rouges. L'équipe de gestion et le personnel de l'hôtel Crowne Plaza seront également désireux de vous aider. Nous espérons tous que vous apprécierez non seulement le congrès, mais que vous saurez prendre le pouls de la capitale du Canada.

John Falkingham
Président
Comité des dispositions local
Congrès SCMO-UGC 2010

Un mot au sujet des sociétés

SCMO

La société canadienne de météorologie et d'océanographie (SCMO) est une société nationale de personnes et d'organisations vouées à l'avancement des sciences atmosphériques et météorologiques et aux disciplines environnementales connexes au Canada. La Société vise à promouvoir la météorologie et l'océanographie au Canada. C'est un organisme non gouvernemental, servant les intérêts des météorologues, océanographes, limnologues, hydrologues et scientifiques cryosphériques au niveau national et international. La SCMO a une riche histoire qui remonte à 1939 alors qu'elle était connue sous le nom de Section canadienne de la " Royal Meteorological Society". La SCMO a vu le jour officiellement en 1967 et a adopté son nom actuel en 1977 après que la Société météorologique du Canada eut invité la communauté océanographique du Canada à se joindre à elle.

UGC

Le 24 octobre 1945, le Conseil national de recherches Canada (CNRC) convoquait, sous la présidence de J. T. Wilson, la première rencontre d'un Comité associé pour le conseiller sur les besoins en géophysique. En 1946, ce comité associé fut amalgamé avec le comité canadien pour l'Union Géodésique et Géophysique Internationale (UGGI) pour former le Comité associé de la géodésie et de la géophysique (CAGG) du CNRC Des activités des géophysiciens au Canada ont été coordonnées par CAGG en formant un certain nombre de sous-comités.

En 1974, le CAGG fut remplacé par une société professionnelle appelée " l'Union géophysique canadienne, une division jointive de l'Association géologique du Canada (AGC) et de l'Association canadienne des physiciens et physiciennes (ACP) ", avec J. T. Wilson en tant que son premier président. L'Union géophysique canadienne est devenue une organisation indépendante en 1988, mais aujourd'hui les géophysiciens peuvent encore joindre l'UGC en joignant l'ACP ou la Division de géophysique de l'AGC. L'UGC comporte quatre sections scientifiques: Hydrologie (depuis 1993), Géodésie (depuis 2002), Solide terrestre (depuis 2009) et Biogeosciences (depuis 2009). Maintenant avec environ 500 membres, l'UGC sert de foyer national aux sciences géophysiques et continue la responsabilité traditionnelle de représenter le Canada dans l'UGGI par un Comité national canadien (CNC/UGGI).

Récipiendaires des bourses de voyage pour étudiants

Étudiant(e)	Université
Alipour, Samira	Université de l'Ouest de l'Ontario
Assini, Jane	Université York
Baglaenko, Anton	Université de Waterloo
Bedard, Joel	École de technologie supérieure
Beedle, Matt	Université du Nord de la Colombie-Britannique
Bhattacharya, Pathikrit	Université de l'Ouest de l'Ontario
Blanchette, Jean-Philippe	L'Université du Québec à Montréal (UQAM)
Brazzard, Andrea	Université McMaster
Brunet, Nathalie	Université de la Saskatchewan
Bunn, Melissa	Université de Waterloo
Burles, Katie	Université de Lethbridge
Casson, Nora	Université Trent
Chen, Bin	Université McMaster
Cho, Nelson	Université de l'Ouest de l'Ontario
Christensen, Brendan	Université de Calgary
Corkum, Mathew	Université York
Croft, Alison	Université York
Di Luca, Alejandro	L'Université du Québec à Montréal (UQAM)
Duval, Tim	Université McMaster
Elghazouly, Ahmed	Université de Calgary
Fargey, Shannon	Université du Manitoba
Fereydouni, Azadeh	Université de l'Ouest de l'Ontario
Gaitan, Carlos	Université de la Colombie-Britannique
Ghofrani, Hadi	Université de l'Ouest de l'Ontario
Giroux, Kayla	Université Wilfrid Laurier
Halla, Jamie	Université York
Harder, Silvie	Université de Victoria
Higginson, Simon	Université Dalhousie

Étudiant(e)	Université
Hodal, Michal	Université de la Colombie-Britannique
Huang, Suo	Université McMaster
Ince, Elmas	Université de Calgary
Katavouta, Anna	Université de l'Alberta
Kenward, Andrea	Université Wilfrid Laurier
Khajehnouri, Yasaman	École Polytechnique de Montréal
Kiarasi, Souhyant	Université de l'Ouest de l'Ontario
Koumoulas, Panagiotis	Université York
Lago, Veronique	Université de l'Alberta
Lau, Justin	Université de la Colombie-Britannique
Leduc, Martin	L'Université du Québec à Montréal (UQAM)
Lefort, Stelly	Université McGill
Lu, Zhaoshi	Université Memorial
Ma, Zhimin	Université Memorial
Mahmood, Sharif	Université de Calgary
Malik, Khalid	Université York
Markovic, Marko	L'Université du Québec à Montréal (UQAM)
Marsh, Chris	Université de la Saskatchewan
Mashayek, Ali	Université de Toronto
Matveev, Alex	L'Université du Québec à Montréal (UQAM)
McLarty, Jennifer	Université York
Mladjic, Bratislav	L'Université du Québec à Montréal (UQAM)
Mosquera, John	Université de Waterloo
Nagare, Ranjeet	Université de l'Ouest de l'Ontario
O'Leary, Sheilagh	Université Memorial
PaiMazumr, Debasish	L'Université du Québec à Montréal (UQAM)
Pal, Jalpa	Université de l'Ouest de l'Ontario
Paque, Gwenaelle	L'Université du Québec à Montréal (UQAM)
Paquin, Jean-Philippe	L'Université du Québec à Montréal (UQAM)

Étudiant(e)	Université
Paquin-Ricard, Danahé	L'Université du Québec à Montréal (UQAM)
Payeur-Poirier, Jean-Lionel	Université Laval
Perro, Chris	Université Dalhousie
Pryse-Phillips, Amy	Université Memorial
Ross, Andrew	Université Concordia
Sanchez, Laura	Université de l'Ouest de l'Ontario
Sato, Mei	Université de Victoria
Sawyer, Ryan	Université de l'Ouest de l'Ontario
Seagram, Annie	Université de la Colombie-Britannique
Seitz, Nicole	Université de la Saskatchewan
Shan, Shiliang	Université Dalhousie
Smith, Karen	Université de Toronto
Soontiens, Nancy	Université de Waterloo
Steelman, Colby	Université de Waterloo
Steinmoeller, Derek	Université de Waterloo
Thompson, Dan	Université McMaster
van der Laan, Michael	Université de la Colombie-Britannique
Vanos, Jenni	Université de Guelph
von de Wall, Simon Julius	Université de Victoria
Wagner, Michael	Université de l'Alberta
Yadghar, Amir	Université Concordia
Yan, Xiaoqin	Université du Nord de la Colombie-Britannique
Yang, Dejian	Université du Nord de la Colombie-Britannique
Zhang, Ying	Université Memorial
Zhou, Yang	Université Dalhousie

Comité des dispositions local

John Falkingham	Président
Wayne Richardson	Trésorier
Sean Carey	Secrétaire
Isabel Ruddick	Inscription
Erica Wilson / Bruce Ramsay	Locaux
Wayne Lumsden / Brian Beamish	Technologie, audio-visuel
Paul Pestieau	Communications
Mario Ouellet	Programme du congrès
Bob Jones	Webmestre
Anne O'Toole	Commanditaires / exposants
Oscar Koren / Terry Fanning	Exposants
Sheila Bourque / Emily Bourque	Journée des enseignants
Elaine Moores	Coordinateur des bénévoles
Spiros Pagiatakis / Kathy Young	Liaison bureau UGC
Ian Rutherford	Directeur exécutif de la SCMO
Denis Bourque	Président, Centre SCMO d'Ottawa
Sean Carey	Membre général

Comité du programme scientifique

Dick Stoddart / Rod Blais - Co-présidents	John Stone - EC/MSC (retraité)
Altaf Arain - Université McMaster	Leah Braithwaite - EC/Service canadien des glaces
Doug Whelpdale - EC/SMC (retraité)	Peter Taylor - Université York
Gail Atkinson - Université de l'Ouest de l'Ontario	Sam Butler - Université Saskatchewan
Howard Freeland - MPO/IOS	Sean Carey - Université Carleton
Ian Rutherford - SCMO	Spiros Pagiatakis - Université York
Joe Henton - RNCan	Tim Aston - FCSA

Bénévoles

John Anderson	Panagiotis Koumoulas
Martha Anderson	Harry Lamb
Matt Arkett	Andy (Yuehua) Lin
Richard Asselin	Ann McMillan
Jane Assini	Ilona Monahan
Ryan Ballingall	Colleen Mortimer
Paul Beckwith	Lidia Nikitina
Wendy Benjamin	Lynn Pogson
Yvon Bernier	Sierra Pope
Jorge Urrego Blanco	Jana Ramsay
Mike Brady	Louise Reid
Dawn Conway	John Reid
Allison Croft	Amanda Reinwald
Kelly Crowe	Shiliang Shan
Lesley Elliott	Jennifer Smith
Cheryl Falkingham	Margaret-Anne Stroh
Irenka Farmilo	Marty Taillefer
Norah Foy	Colleen Turnbull
Dave Henderson	Anne-Marie Valton
John Hollins	Wesley Van Wychen
Dave Huddlestone	Adrienne White
Sergio Ieropoli	Katherine Wilson
Richard Jones	Amir Yadghar
Peter Kimbell	

Information

Directives pour présentations orales

Veuillez vous assurez que l'identification des fichiers électroniques de vos présentations comprennent le numéro de la session, le numéro de la présentation et le nom du présentateur et/ ou de la présentatrice. Nous aurons des volontaires dans les salles de conférences au moins 30 minutes avant le début des sessions pour assister avec le chargement des présentations. Vous devrez apporter votre présentation dans la pièce ou se tiendra votre session au moins 15 minutes avant le début de la session. Les ordinateurs du Congrès sont équipés avec Microsoft Windows XP Pro, les logiciels Microsoft Office 2007 Pro, le lecteur Adobe Acrobat, le lecteur Quicktime et le lecteur Windows Media. Veuillez apporter vos présentations sur un des média suivant : lecteur disque dur USB, lecteur éclair USB, CD ou DVD. Les présentateurs/présentatrices seront capables d'éditer leurs présentations sur place en utilisant un ordinateur portable avec port USB. Notez que si des extraits vidéo sont utilisés dans vos présentations ils doivent être téléchargés dans le même répertoire que la présentation Power Point principale. Les présentations générées sur un Macintosh et converties pour rouler sur un PC doivent être examinées sur un PC avant d'arriver à l'assemblée. Dans les cas où la conversion de la présentation n'est pas possible, nous tenterons de brancher un ordinateur Macintosh directement au projecteur LCD. N'importe quel lien devrait être vérifié à l'assemblée afin de s'assurer qu'il fonctionne bien. Veuillez remarquer qu'il n'y a pas de ligne internet sur les ordinateurs dédiés aux présentations. Il y aura un ordinateur et un projecteur dans la chambre de préparation des conférenci(ers/ères) afin de permettre l'essai de leurs présentations.

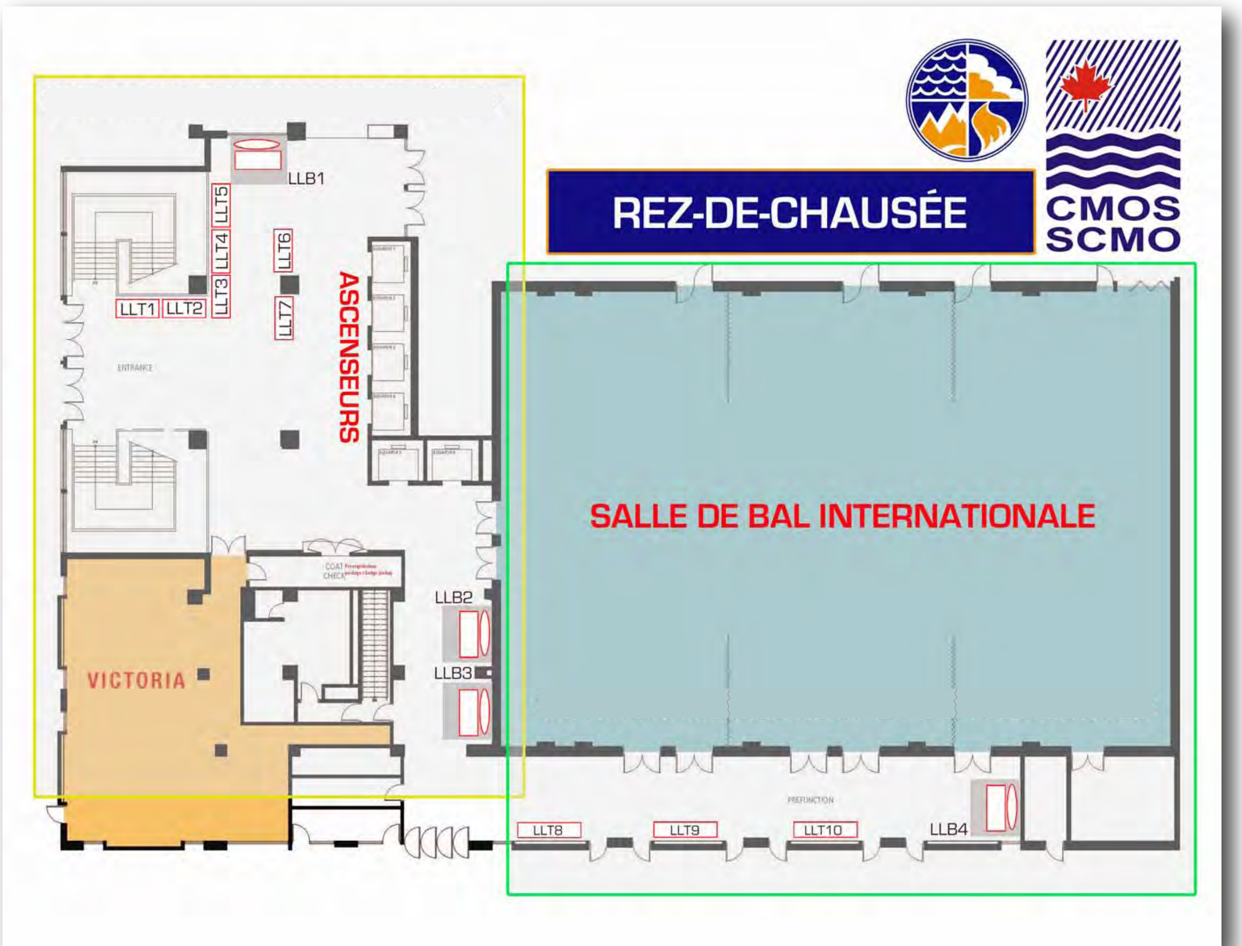
Présentations des affiches

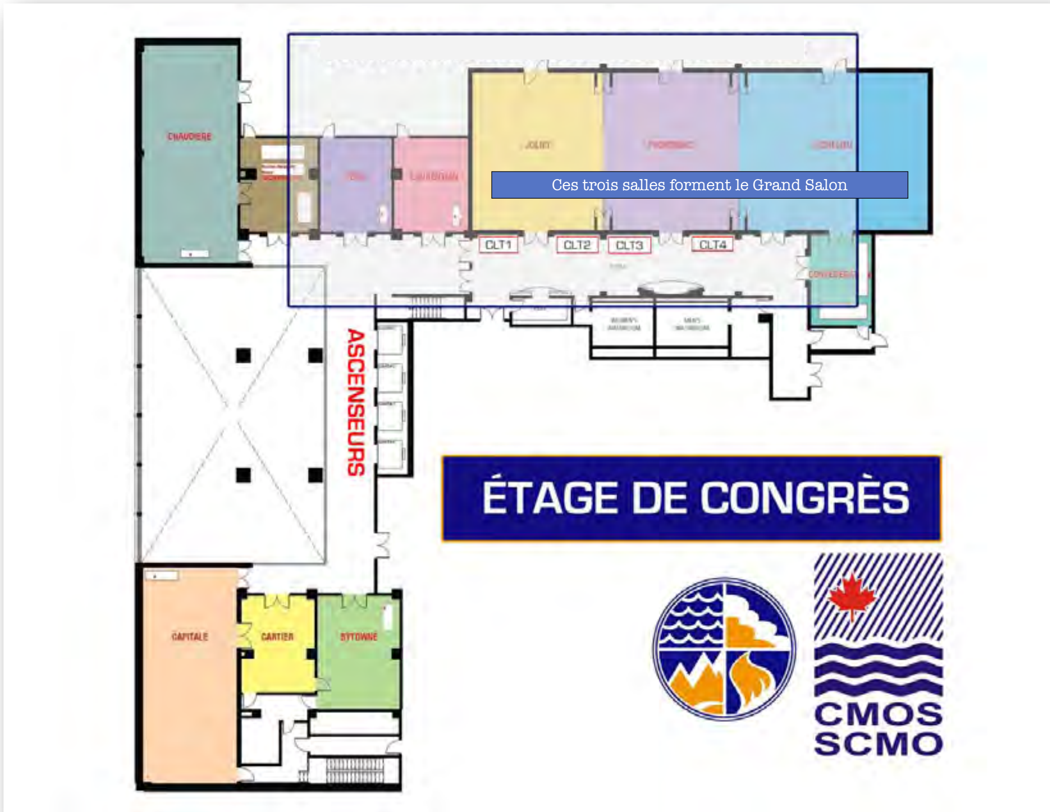
Les affiches scientifiques pour le Congrès seront situées sur la terrasse de l'hôtel Crowne Plaza. Les affiches seront exposées pour la durée du Congrès. Chaque affiche est allouée un espace de 4 pi (1.2 m) par 4 pi (1.2 m). Les tableaux d'affichages peuvent accepter le Velcro ou les épingles (une provision des deux sera disponible). Les affiches pourront être montées en tout temps après 15 :30 le lundi pour les présentations du mardi et de même le mercredi pour les présentations du jeudi. Les présentateurs/ présentatrices devront demeurer près de leurs affiches pour expliquer leur travail durant la période assignée à la session d'affichage. Les affiches devront être enlevées vers la fin de la pause du matin la journée suivant leur présentation.

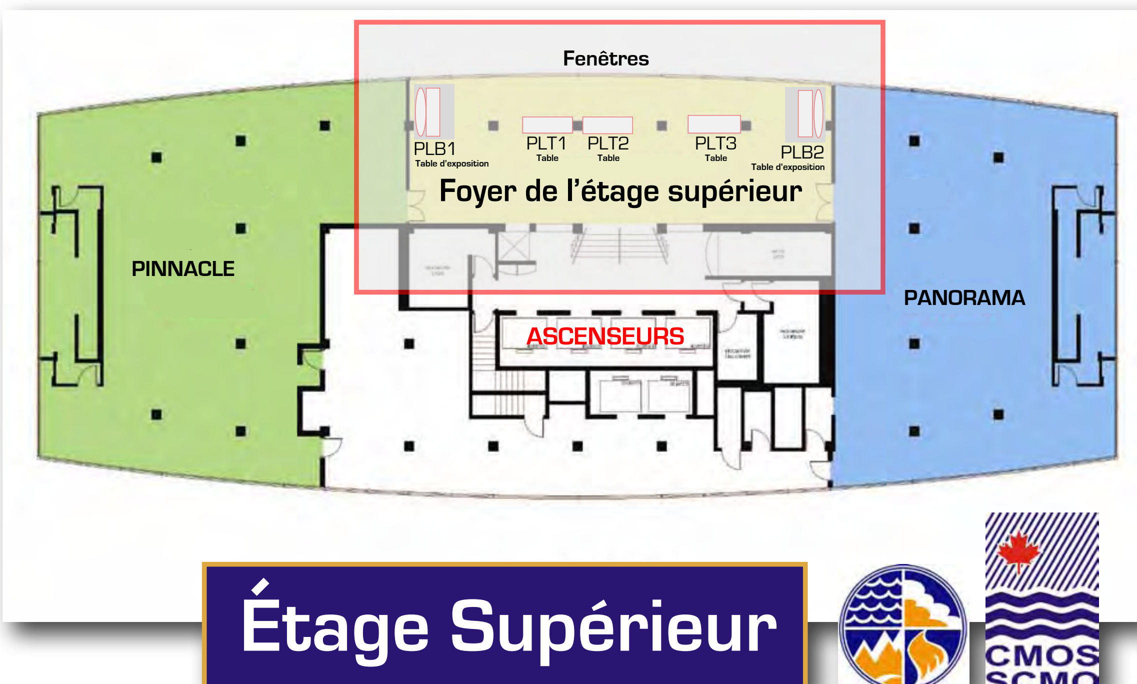
Pour les président(e)s de session

Un/une assistant(e) sera présent(e) dans chaque salle de conférence. L'assistant(e) sera disponible pour aider à résoudre les problèmes techniques de l'audio-visuel ou d'ordinateur. Chaque ordinateur sera équipé des logiciels suivants : Microsoft Office 2007 Pro, lecteur Adobe Acrobat, lecteur Quicktime et lecteur Windows Media. Avant le début de la session, le/la président(e) devra communiquer avec l'assistant(e), vérifier si toutes les présentations sont chargées dans l'ordinateur et si tous les conférenci(ers/ères) sont présent(e)s dans la chambre de session. Avant le début de la session le/la président(e) devra s'assurer que chaque conférenci(er/ère) soit inscrit(e) dans le programme comme conférenci(er/ère) ,ou comme auteur(e), et que chacun/chacune soit suffisamment familier avec le travail pour répondre aux questions. Le/la président(e) est responsable de faire observer le temps d'ouverture et de fermeture de la session. Le temps alloué pour une présentation inclut la période pour les questions et discussions, ainsi que le changement de conférenci(er/ère). Par considération pour les autres sessions qui se déroulent en parallèle, le temps alloué pour chaque session devra être observé strictement. Un minuteur sera disponible dans chaque salle de conférence Si un espace imprévu apparaît à l'horaire, ce temps devra être rempli soit par une présentation en réserve, ou une prolongation de la période de questions sur la présentation précédente, soit par une courte description des affiches pertinentes à la session actuelle. La mise à jour du programme de session sera affichée à l'extérieur de la salle bien avant le début de la session. Le/la président(e) recevra une copie de l'assistant(e) assigné(e) à la salle.

Cartes des sites




Ces trois salles forment le Grand Salon
CLT1
CLT2
CLT3
CLT4
ASCENSEURS
ÉTAGE DE CONGRÈS
CMOS
SCMO


Fenêtres
PLB1
Table d'exposition
PLT1
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PLT2
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PLT3
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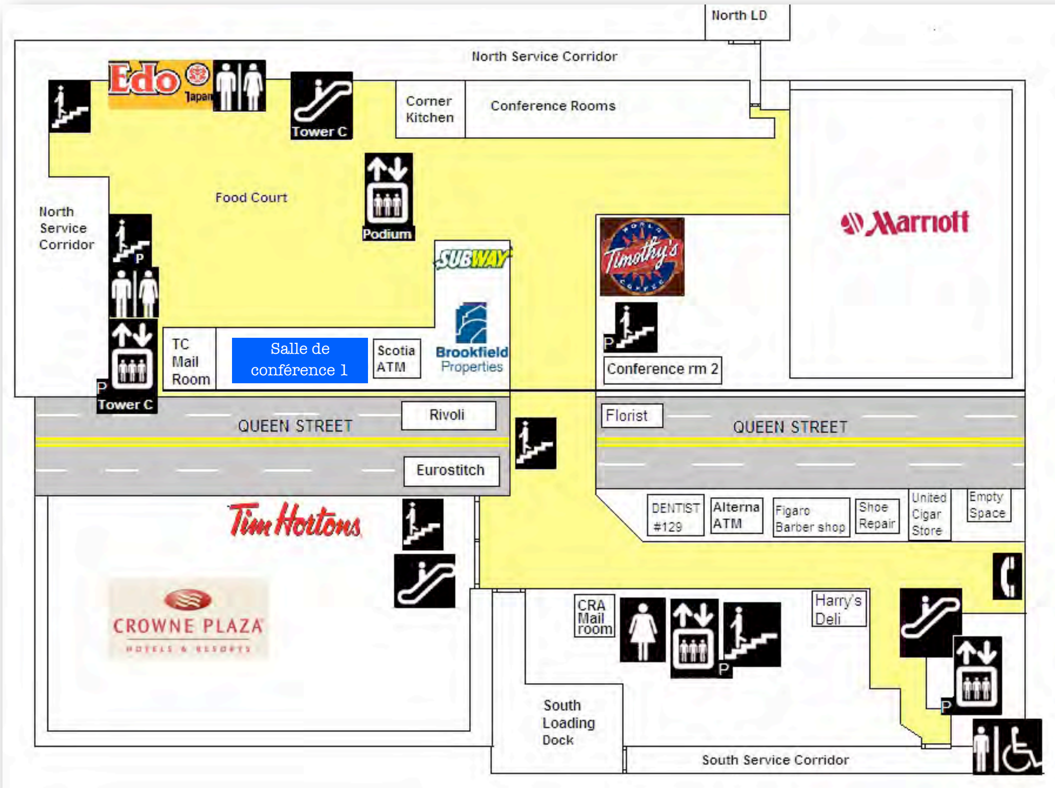
PLB2
Table d'exposition
Foyer de l'étage supérieur
PINNACLE
PANORAMA
ASCENSEURS
Étage Supérieur
CMOS
SCMO



NOTE: "Salle de conférence 1" dans l'aperçu de la semaine et l'horaire des sessions fait référence à une salle située à l'extérieur du Crowne Plaza mais néanmoins accessible par un passage sous-terrain. La carte ci-dessus montre où se situe la Salle de conférence 1.

Liste des exposants

La disposition des kiosques/tables est indiquée sur les cartes des pages précédentes

Exposant	Lien web	Kiosque/table
Étage du Congrès		
Presses scientifiques du CNRC	http://pubs.nrc-cnrc.gc.ca/fra/index.html	CLT1
WeatherBug Professional	http://weather.weatherbug.com/weatherbug-professional/	CLT2 et CLT3
Taylor & Francis	www.tandf.co.uk/journals/	CLT4
Rez-de-chaussée		
ATS Technology Systems Inc	www.atstechnology.ca	LLB1
Campbell Scientific Canada Corp	http://www.campbellsci.ca/index_f.html	LLB2
Info-Electronics Systems Inc	www.info-electronics.com	LLB3
Vaisala Inc	http://www.vaisala.fr/index.aspx	LLB4
JouBeh Technologies	www.joubeh.com/	LLT1
Fugro Airborne Surveys	www.fugroairborne.com	LLT2
La Fondation canadienne pour les sciences du climat et de l'atmosphère	www.fcsca.org	LLT3
La Société canadienne de météorologie et d'océanographie	www.scmo.ca	LLT4
Union géophysique canadienne	www.cgu-ugc.ca	LLT5
Environnement Canada	www.ec.gc.ca	LLT6
ASL Environmental Sciences	www.aslenv.com	LLT7
Integrated Science Data	http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/index-fra.html	LLT8
MDA Corporation	www.mdacorporation.com	LLT9
ECO Canada	http://www.eco.ca/Portal/default.aspx	LLT10
Étage supérieur		
AXYS Technologies Inc	www.axystechnologies.com	PLB1
Hoskin Scientific Ltd	www.hoskin.qc.ca/accueil	PLB2
Société Radio-Canada	www.cbc.ca	PLT1
RBR LTD	www.rbr-global.com	PLT2
Réseau canadien de détection des changements atmosphériques	www.candac.ca	PLT3

Activités sociales

Banquets

Le jeudi, en soirée, la SCMO et l'UGC tiendront simultanément, mais séparément, leurs banquets de remise de prix. Le banquet de l'UGC aura lieu dans le Grand Salon du Crowne Plaza (dans les salles Richelieu-Frontenac-Joliet) et celui de la SCMO se déroulera dans la salle de bal Internationale.

Tous les participants inscrits pour toute la durée du congrès recevront un billet pour le banquet correspondant aux événements sociaux indiqués lors de l'inscription. L'inscription en ligne permet de se procurer des billets supplémentaires pour les invités. Quelques billets supplémentaires pourront être achetés à la dernière minute au bureau d'inscription du congrès, mais les quantités pourraient être limitées.

Brise-glace

L'activité " brise-glace " du congrès aura lieu le lundi 31 mai entre 18 h et 22 h dans les salles Pinnacle/ Panorama à l'étage du toit-terrasse de l'hôtel Crowne Plaza. Les fenêtres sur toute la hauteur des salles offrent une vue à couper le souffle du centre-ville d'Ottawa, de la rivière des Outaouais et des collines qui jalonnent la ville de Gatineau. Des rafraîchissements seront disponibles et des hors-d'œuvre chauds et froids seront servis tout au long de la soirée. Vous aurez l'occasion d'échanger avec collègues et amis sur fond de musique jazz offerte dans la salle Panorama par le groupe " CMC Jazz Ensemble ", quartet composé de quatre musiciens de Montréal.

Chaque personne inscrite recevra un billet pour l'activité " brise-glace ". Des billets SUPPLÉMENTAIRES pour des invités peuvent être achetés pendant l'inscription en ligne. Quelques billets supplémentaires seront disponibles pour l'achat de dernière minute au bureau d'inscription du congrès mais la disponibilité peut être limitée. L'événement d'ouverture de notre congrès à Ottawa promet d'être spectaculaire. Ce sera l'occasion idéale de retrouver d'anciens collègues, de faire de nouvelles rencontres et d'entamer de belle façon cette semaine de congrès, qui sera certainement excitante et stimulante!!

Dîner avec le professeur Mysak

Mardi midi, un dîner spécial serafert en l'honneur du professeur Lawrence A. Mysak dans la salle de bal B. Les billets retenus pour participer à cet événement spécial seront facturés en sus dans le cadre du processus d'inscription.

Dîner Patterson-Parsons

Mercredi midi, la Société canadienne de météorologie et d'océanographie (SCMO) sera l'hôte du dîner Patterson-Parsons dans la salle de bal internationale. La médaille Patterson est offerte annuellement par le Service météorologique du Canada à titre de récompense pour éminents services en météorologie au Canada. La médaille Timothy R. Parsons, qui souligne l'excellence en sciences océaniques, est offerte annuellement à des scientifiques canadiens par Pêches et Océans Canada, en reconnaissance de leur importante contribution à la recherche océanique multidisciplinaire au cours de leur carrière ou en reconnaissance d'une réalisation exceptionnelle dans leur travail au sein d'une institution canadienne.

Barbecue de l'UGC

Mercredi midi, l'Union géophysique canadienne (UGC) sera l'hôte d'un barbecue informel sur la terrasse. À cette occasion, les membres de l'UCG pourront se rassembler pour rencontrer de nouveaux membres et renouer avec de vieilles connaissances.

Chaque inscription pour la durée entière du congrès comprend un billet pour assister soit au dîner Patterson-Parsons, soit au barbecue de l'UCG. Les participants devront choisir à quel événement ils souhaitent prendre part lorsqu'ils s'inscriront. Vous pouvez vous procurer des billets supplémentaires pour des invités au cours du processus d'inscription en ligne. Quelques billets supplémentaires seront disponibles pour des achats de dernière minute au bureau d'inscription du congrès, mais leur quantité pourrait être limitée.

Conférence publique

Comme nos pôles fondent, la Vie y change aussi

L'Arctique et les régions maritimes de l'Antarctique se réchauffent présentement bien plus rapidement que le reste de la planète. Cette tendance est attendue à s'accélérer au courant du 21ème siècle. Déjà il y a des signes écologiques du changement occasionné dans les deux régions polaires, incluant des perturbations dans les habitats, les distributions d'espèces et les chaînes alimentaires. Cette présentation répondra aux questions suivantes: comment les écosystèmes polaires de la Terre changent-ils, et vers quel nouveau régime?

Le professeur Warwick F. Vincent est un scientifique de renommée internationale qui se consacre à étudier de quelle façon la vie à la base des réseaux alimentaires en milieu aquatique réagit aux changements environnementaux. Originaire de Nouvelle-Zélande, M. Warwick a choisi de venir vivre avec sa famille dans la ville de Québec, il y a près de vingt ans. Il est présentement titulaire de la Chaire de recherche du Canada en études des écosystèmes aquatiques à l'Université Laval; il est aussi directeur du Centre de recherche interuniversitaire et de l'Institut de formation, du Centre d'études nordiques, également installés à l'Université Laval. Ancien président du Comité antarctique national du Canada, un des membres fondateurs du réseau ArcticNet, et récemment directeur de groupe des comités de sélection pour l'attribution des subventions accordées par le CRSNG (Conseil de recherches en sciences naturelles et en génie), il s'est valu de nombreux honneurs pour sa contribution en recherche et en éducation. Il a en outre reçu la récompense Canadian Rigler Prize en limnologie, il s'est vu remettre la Médaille d'or en sciences, attribuée par la Nouvelle-Zélande, ainsi que la Médaille Miroslaw Romanowski de la Société royale, pour ses accomplissements dans le domaine de la recherche environnementale.

Où et quand: 20h00, mercredi 2 juin
Hôtel Crowne Plaza - Salle de bal principale

Introduction aux médias
Un atelier pour les chercheurs

Peter Calamai, journaliste scientifique chevronné, dévoile les rouages internes et la culture médiatique pour que les scientifiques puissent mieux communiquer avec les médias. Des trucs pratiques seront offerts pour travailler avec des journalistes ayant divers degrés d'aisance avec la science, éviter des erreurs communes et répondre aux exigences particulières de la télévision.

Jeudi le 3 juin, 17h30-18h30

À noter: La session sera en anglais uniquement.

Pour plus de renseignements, voir Kelly Crowe au kiosque de la Fondation canadienne pour les sciences du climat et de l'atmosphère.

Journée des enseignants

Cette année, dans le cadre de la Journée des enseignants (le 3 juin), six présentateurs[1] fourniront aux enseignants des renseignements utiles sur différents domaines scientifiques et programmes d'éducation. Certains présentateurs, qui sont des experts dans leurs domaines respectifs et qui représentent les intérêts principaux de la SCMO et de l'UGC, proposeront aux enseignants de l'information récente sur leurs domaines scientifiques au Canada. D'autres conférenciers fourniront des renseignements sur les activités en classe que les enseignants peuvent faire immédiatement. Les membres des deux sociétés ont fait preuve d'une énorme générosité en choisissant et en donnant le matériel qui se trouve dans les trousses que chaque enseignant recevra. La SCMO a organisé un événement d'une journée dans le cadre de la Journée des enseignants de la maternelle à la 12e année, dans le cadre du Congrès annuel qui se déroule maintenant depuis plusieurs années. Il n'en coûte rien aux enseignants de participer à la Journée des enseignants de 2010. La SCMO croit qu'elle doit susciter l'enthousiasme et encourager la sensibilisation à l'égard des sciences atmosphériques et océaniques chez les jeunes d'âge scolaire. Cette année, elle est fière de s'associer à l'UGC. Les enseignants assisteront à une présentation sur les sciences de la Terre. En participant à cet événement, les enseignants pourront agir à titre d'agents multiplicateurs pour tenter de s'assurer que les élèves d'aujourd'hui sont exposés aux sciences géophysiques.

"Climate Change: Are You Confused?"
Dr John Stone, Professeur, Département de géographie et d'études environnementales, Université Carleton

"Moving Day in Canada - earthquake science and human impact"
Stella Heenan, Consortium POLARIS

"eCards - eLearning on our Changing Climate"
Gordon Harrison, Directeur, GreenLearning Canada

"What's really happening to Arctic sea ice?"
Doug Bancroft, Directeur, Service canadien des glaces, Environnement Canada

"Environmental Video Conferencing"
René Brunet, Coordonnateur d'éducation à distance et des vidéoconférences / Animateur La Biosphère, Environment Canada

"Weather - Everywhere and Everyday"
Phil Chadwick, Météorologue, Environnement Canada

[1] Les présentations seront faites en anglais seulement.

Conférenciers des plénières

John Adams, Ph. D. - Commission géologique du Canada, Ressources naturelles Canada

John a obtenu un doctorat en géologie de l'Université de Victoria de Wellington, en Nouvelle-Zélande, en 1978. Il travaille à la Commission géologique du Canada depuis 29 ans, et a contribué à tous les aspects du programme sur les tremblements de terre, y compris aux enquêtes sur le terrain sur les répliques sismiques, à la gestion du programme et à la création de cartes nationales des dangers sismiques. Il a aussi participé à des visites de reconnaissance en ingénierie après les tremblements de terre. John s'intéresse aux domaines de recherche comme la sismotectonique des tremblements de terre au Canada, les éléments de preuve des paléoséismes ainsi que les déformations de la croûte terrestre qui orientent la néotectonique et la géomorphologie afin de savoir si et comment ces domaines peuvent s'appliquer à l'amélioration des prévisions des dangers sismiques.

John a été le sismologue en chef de l'élaboration des cartes des dangers sismiques utilisées dans la dernière version du Code national du bâtiment du Canada. De plus, il fournit des conseils de nature générale sur les dangers sismiques, il fait partie du Comité permanent canadien chargé du calcul des forces sismiques, dont les données recueillies seront intégrées aux dispositions de la prochaine version du Code du bâtiment, et il appuie divers comités de l'Association canadienne de normalisation chargés d'élaborer les dispositions sur les tremblements de terre pour les structures essentielles comme les centrales nucléaires. Il collabore à l'évaluation réglementaire des rapports sur les dangers sismiques concernant des structures importantes comme les centrales nucléaires, les usines de GNL, les barrages et les pipelines, et a effectué un examen préalable pour les ambassades canadiennes à l'étranger. John occupe présentement le poste de trésorier de l'Association canadienne du génie parasismique.

Michel Béland, Ph. D., Environnement Canada, Service météorologique du Canada

Michel Béland a obtenu son doctorat en météorologie à l'Université McGill, en 1977, dans le domaine de la dynamique de l'atmosphère et de la prévision météorologique numérique. De janvier 1973 jusqu'à sa retraite, en juillet 2008, M. Béland a travaillé à Environnement Canada, d'abord à titre de météorologue et par la suite comme chercheur dans le domaine de la prévision et de la modélisation atmosphérique mondiale. Il a ensuite été directeur de recherche avant d'être nommé directeur général des Sciences et de la technologie atmosphériques. M. Béland a aussi pris trois congés sabbatiques, deux d'entre eux au Laboratoire de météorologie dynamique de Paris, et le troisième au CERCA (centre de recherche en calcul appliqué), où il a occupé les postes de président et de directeur général. EC l'a rappelé en septembre 2008 pour un emploi à temps partiel, et il est présentement le conseiller du nouveau directeur général des Sciences et de la technologie atmosphériques, où il remplit un certain nombre d'obligations internationales, principalement comme directeur de la Commission des sciences de l'atmosphère de l'Organisation météorologique mondiale, avec laquelle il terminera son premier mandat de quatre ans en novembre 2009. Il a aussi été président du comité directeur central international de THORPEX, un programme mondial de recherche sur l'atmosphère, de sa création en 2003 jusqu'en avril 2007. Il est présentement coprésident du Comité mixte international pour l'Année polaire internationale 2007-2009, jusqu'à son abrogation en juin 2010, au cours de la Conférence internationale sur les sciences polaires à Oslo. En 1995, M. Béland a occupé le poste de président de la Société canadienne de météorologie et d'océanographie (SCMO). Il a récemment reçu la Médaille Patterson du SMC pour services rendus à la météorologie, et a également été nommé membre émérite de la SCMO. Ses plus récentes contributions scientifiques sont dans les domaines de la prévision environnementale et de la modélisation uniforme. Il a toujours cherché à faire avancer ce concept au sein d'EC, parfois à l'aide de partenariats avec d'autres ministères, et tout récemment à l'échelle internationale, lorsque le Conseil exécutif de l'OMM a approuvé les recommandations du Comité d'experts internationaux que M. Béland a contribué à mettre sur pied. Il est maintenant chargé d'établir la marche à suivre pour l'opérationnalisation éventuelle de ces concepts par le Service météorologique et hydrométéorologique national (SMHN) ou leurs équivalents. Il se concentre sur les travaux de la R et D qui seront requis au préalable dans un certain nombre de disciplines scientifiques.

Marianne Douglas, professeure, Université de l'Alberta

Marianne Douglas est directrice de l'Institut circumpolaire canadien en plus d'être professeure au Département des sciences de la terre et des sciences atmosphériques de l'Université de l'Alberta, à Edmonton. Intéressée par l'histoire naturelle et les liens entre la biologie et la géologie, elle a obtenu un diplôme universitaire en biologie de l'Université Queen's et elle a effectué un stage de formation à Paris avant d'obtenir son diplôme d'études supérieures. Après avoir obtenu son doctorat, en 1993, elle a travaillé deux ans à titre d'attachée de recherche au Département des sciences de la Terre de l'Université du Massachusetts, à Amherst, avant d'accepter un poste d'enseignante au Département de géologie de l'Université de Toronto. C'est là qu'elle a mis sur pied le laboratoire d'évaluation paléoenvironnemental et où elle a été titulaire de la Chaire de recherche du Canada sur les changements planétaires en 2005. En 2006, elle a obtenu un poste à l'Université de l'Alberta. Elle habite actuellement à Edmonton (AB) et à Whitehorse (Yn). Ses recherches sont axées sur l'étude des changements environnementaux dans les régions polaires. Presque tout son travail a été effectué dans l'extrême arctique, au nord du continent canadien, mais elle a aussi mené quelques campagnes sur le terrain en Antarctique. À l'aide de techniques paléolimnologiques, comme l'étude des sédiments dans les lacs, il est possible de reconstituer d'anciennes conditions environnementales et des événements en examinant les microfossiles et tout autre indicateur substitutif incrustés dans les sédiments. Pour identifier les changements, elle a travaillé principalement avec les bioindicateurs algaires, comme les diatomées unicellulaires siliceuses. Les études paléolimnologiques menées sur l'île d'Ellesmere ont révélé que les conditions environnementales de l'eau douce avaient subi des changements sans précédent au cours du dernier siècle, et des études néo-limnologiques à long terme ont démontré que cette tendance se poursuivait à un rythme remarquablement élevé, causant l'assèchement complet de certains étangs. Des données supplémentaires ont indiqué qu'une augmentation de la durée de la période de végétation a eu une incidence sur les écosystèmes à des latitudes élevées.

Richard A. Feely, Ph. D., Pacific Marine Environmental Laboratory de la NOAA

Richard A. Feely est un scientifique chevronné du laboratoire de l'environnement marin du Pacifique de la NOAA, à Seattle. Il est aussi professeur titulaire associé à l'École d'océanographie de l'Université de Washington. Ses recherches portent principalement sur le cycle du carbone océanique et sur le processus d'acidification des océans. Reçu bachelier en chimie de l'Université St. Thomas, à St Paul (Minnesota), en 1969, il a poursuivi ses études à l'Université A et M, du Texas, où il a obtenu une maîtrise en sciences en 1971, et un doctorat, en 1974. Ses diplômes d'études supérieures sont tous deux en océanographie chimique. Il est coprésident du US CLIVAR/ CO2 Repeat Hydrography Program et siège aux comités de direction scientifiques du US Carbon Cycle Science Program, du US Ocean Carbon and Climate Change Program, et du US Carbon and Biochemistry Program. Il est également membre de l'American Geophysical Union, de l'American Association for the Advancement of Science et de l'Oceanography Society. M. Feely est l'auteur de plus de 175 publications de recherche revues par des comités de lecture. Le Gold Award du département du Commerce lui a été décerné en 2006 pour ses recherches d'avant-garde en acidification des océans. M. Feely a été élu membre de l'American Geophysical Union en 2007.

Howard Freeland, Ph. D., Institut des sciences de la mer

Howard Freeland est chercheur scientifique principal à la Division des sciences océanologiques de l'Institut des sciences de la mer, de Pêches et Océans Canada, à North Saanich (C.-B.). Howard a obtenu un baccalauréat de l'Université d'Essex (1968) et un doctorat en océanographie physique de l'Université Dalhousie (1973). À titre de boursier en perfectionnement postdoctoral, il a passé deux ans au Woods Hole Oceanographic Institute, et puis il a occupé le poste de professeur adjoint à l'Université de Rhode Island pendant deux ans, avant de revenir au Canada en 1977.

Howard a concentré ses recherches sur la dynamique des océans, étudiant entre autres la manière dont les ondes du plateau continental sont produites et propagent l'information, l'échange des eaux abyssales entre les bassins océaniques nord et sud du Pacifique ainsi que les tendances à grande échelle et l'évolution des eaux abyssales du Pacifique, de la mer d'Okhotsk et du golfe d'Alaska. Toutefois, au cours de sa carrière, il s'est penché périodiquement sur les problèmes qui concernent l'étude de l'océanographie d'un point de vue lagrangien.

Pendant les 10 dernières années, Howard s'est occupé principalement de la création de l'Argo, le Réseau pour l'océanographie géostrophique en temps réel. Howard a traversé le Canada en tant que conférencier de la Société canadienne de météorologie et d'océanographie (SCMO) en 2001 pour présenter un exposé intitulé " Launching the Argo Armada " (Lancement de l'armada Argo). En ce temps-là, l'Argo n'était guère plus qu'un rêve, et l'équipe de direction internationale de l'Argo était composée de représentants de huit pays seulement, mais Howard prédisait que " nous aurons un réseau mondial de 3 000 flotteurs dans les océans du monde en 2007 ". Ce but a été atteint en novembre 2007.

Howard est coprésident du consortium international Argo, qui comprend actuellement 26 pays, et il est à la tête du groupe canadien de l'Argo.

Michael G. Sideris, Ph. D., Université de Calgary

Michael G. Sideris possède des diplômes en génie géomatique de l'Université technique nationale d'Athènes, en Grèce (1981, Dipl.-Ing., avec distinction), et de l'Université de Calgary, au Canada (M. Sc. en 1984 et doctorat en 1988). Il a aussi obtenu un doctorat honorifique (Dr honoris causa) en géodésie de l'Université d'architecture, de génie civil et de géodésie de Sofia (Bulgarie) en 2004. Après avoir obtenu son doctorat, il est entré au département de génie géodésique de l'Université de Calgary, où il est maintenant professeur et doyen associé à la faculté des études supérieures. Ses recherches portent sur l'approximation du champ gravitationnel, la modélisation spatiale et temporelle du géoïde, les missions gravimétriques satellitaires spécialisées (CHAMP, GRACE, GOCE), l'altimétrie satellitaire, la gravimétrie aérienne, les systèmes d'altitude et les données du canevas altimétrique, l'optimisation, et les applications géodésiques des méthodes statistiques, spectrales et des ondelettes. Sa recherche de méthodes efficaces pour établir rigoureusement le géoïde et trouver des solutions aux problèmes des valeurs limites géodésiques lui ont valu une reconnaissance internationale, et le logiciel fondé sur la TFR qu'il a créé est utilisé par les universités, les organismes nationaux et l'industrie dans le monde entier. Il a enseigné à plus de 30 étudiants de M. Sc. et de Ph. D. et il a publié plus de 160 articles dans des revues scientifiques et dans les travaux de congrès revus par un comité de lecture. M. Sideris est un Humboldt International Research Fellow et membre émérite de l'Association internationale de géodésie (AIG) et du Service international du géoïde. Il préside actuellement l'AIG et siège au comité directeur de l'Union géodésique et géophysique internationale (UGGI).

Laurence Smith, professeur, Université de Californie, Los Angeles

Laurence C. Smith est professeur de géographie, coprésident du département de géographie et professeur en sciences de la Terre et de l'espace à l'Université de la Californie, à Los Angeles (UCLA). Il a obtenu un baccalauréat en géosciences de l'Université de l'Illinois, à Urbana-Champaign (1989), une maîtrise en sciences de la Terre de l'Université de l'Indiana (1991) et un doctorat en sciences de la Terre et de l'atmosphère de l'Université Cornell (1996). Ses recherches concernent les cycles de l'eau et du carbone dans la cryosphère, la télédétection, l'hydrologie des rivières septentrionales, les glaciers, les inlandsis, les effets du dégel du pergélisol sur le carbone du sol et les lacs, ainsi que les systèmes de lidar et de radar à synthèse d'ouverture. En 2006, il a présenté au Capitole un exposé sur les incidences probables du changement climatique et, en 2007, ses recherches sur la disparition des lacs sibériens ont occupé une place importante dans le quatrième rapport de l'Évaluation scientifique du Groupe intergouvernemental d'experts sur l'évolution du climat (4RES du GIEC). En 2006-2007, il a été nommé Guggenheim Fellow par la Fondation John S. Guggenheim de New York. Ses autres distinctions comprennent les suivantes : prix du jeune chercheur de la NASA (2000), finaliste de la NASA au prix présidentiel en début de carrière (2002), " 100 meilleures histoires scientifiques " de la revue Discover (2006), et résidence Bellagio de la Fondation John D. Rockefeller (2007). Il est en train d'écrire un livre de vulgarisation scientifique THE NEW NORTH: Our World in 2050 (Le nouveau Nord - Notre monde en 2050), qui sera publié par Dutton, Penguin Group et autres, en 2010.

Susan Solomon, Ph. D., National Oceanic and Atmospheric Administration

Susan Solomon est reconnue comme chef de file dans le domaine de la science atmosphérique. Depuis qu'elle a obtenu son doctorat en chimie de l'Université de Californie à Berkeley en 1981, elle occupe le poste de chercheuse à la National Oceanic and Atmospheric Administration. Ses articles scientifiques ont fourni non seulement des mesures importantes, mais aussi une compréhension théorique de la destruction de l'ozone et, surtout, du rôle de la chimie de surface. En 1986 et 1987, elle a été chercheuse en chef de l'expédition nationale sur l'ozone à la station McMurdo (Antarctique) où elle a pris les premières mesures qui ont indiqué que les chlorurofluorurocarbones sont à l'origine du trou de la couche d'ozone. En 1994, un glacier de l'Antarctique a été nommé en son honneur pour souligner ces travaux. En mars 2000, elle a reçu la National Medal of Science, la distinction scientifique la plus importante des États-Unis, pour " ses observations importantes sur l'origine du trou de la couche d'ozone en Antarctique. "

Nombre de distinctions et de prix lui ont été décernés, dont les prix les plus prestigieux de l'American Geophysical Union (la médaille Bowie), de l'American Meteorological Society (la médaille Rossby) et de la Geochemical Society (la médaille Goldschmidt). Lauréate du Commonwealth Prize et du prix Lemaître, ainsi que du prix de l'ozone et du prix de la Convention de Vienne du Programme des Nations Unies pour l'environnement, elle a été honorée par la revue R&D en tant que " scientifique de l'année " en 1992. Le prestigieux prix Planète bleue lui a été décerné en 2004 pour " recherches novatrices servant à déterminer les mécanismes qui produisent le trou de la couche d'ozone en Antarctique ". De nombreuses universités, des États-Unis et d'ailleurs, lui ont décerné des doctorats honorifiques. Elle est membre de la U. S. National Academy of Sciences et de l'American Philosophical Society, associée étrangère de l'Académie française des sciences, de la Royal Society, de la Royal Society of Chemistry et de l'Académie européenne des sciences. Ses recherches actuelles concernent notamment le changement climatique et l'appauvrissement de l'ozone. Elle a coprésidé la quatrième évaluation du Groupe de travail 1 du Groupe intergouvernemental d'experts sur l'évolution du climat (GIEC), qui donne des informations scientifiques à la Convention-cadre des Nations Unies sur les changements climatiques. Le GIEC et Albert Gore, Jr ont obtenu conjointement le prix Nobel de la paix en 2007. Nommée l'une des 100 personnes les plus influentes par le magazine Time en 2008, elle a aussi obtenu la Grande Médaille de l'Académie des sciences, à Paris, pour son leadership en science de l'ozone et du climat, en 2008, et le prix Volvo de l'environnement, en 2009.

Description des Sessions scientifiques

ATMOSPHÈRE
Séance générale sur les sciences atmosphériques

Doug Whelpdale - EC – Direction générale des sciences et de la technologie
Contact: douglas.whelpdale@ec.gc.ca

Cette séance portera sur les contributions aux sciences atmosphériques qui ne seront pas présentées au cours de séances spécialisées. Sujets d'intérêt : analyses météorologiques des épisodes importants de vent et de précipitation, assimilation des données des systèmes de prévision numérique et aspects opérationnels des prévisions météorologiques.

Interactions nuages-aérosols
Philip Austin - Département des sciences de la Terre et d'océanographie, Université de la Colombie-Britannique
Jonathan Abbatt - Département de chimie, Université de Toronto
Knut Von Salzen - Centre canadien de la modélisation et l'analyse climatique, Environnement Canada
Howard Barker - Recherche en physique des nuages et en phénomènes météorologiques violents, Environnement Canada
Contact: paustin@eos.ubc.ca

Les aérosols atmosphériques jouent un rôle majeur dans la détermination des propriétés physiques des nuages et sont modifiés à leur tour par les processus des nuages par l'entremise du lessivage par les précipitations et de la chimie de phase aqueuse. Afin de mieux comprendre cette réciprocité on se doit d'obtenir des estimations plus précises de l'impact radiatif actuel des nuages et des aérosols sur les climats passés et courants, et de mieux estimer la sensibilité du climat aux changements dans les nuages et les aérosols, compte tenu du fait que la planète se réchauffe. Dans cette séance, on présentera de nouveaux travaux s'appuyant sur des observations par satellite, des études expérimentales et des modélisations mondiales, régionales et à petite échelle de nuages et d'aérosols. Voici des exemples de ce que l'on pourrait présenter :

1) mesures se rapportant aux nuages et aux aérosols effectuées à l'aide des satellites actifs et/ou passifs ;

2) études mondiales et régionales de modélisation de nuages et d'aérosols, y compris les résultats des comparaisons du réseau Rétroactions nuages?aérosols et climat de la FCSCA et des études sur les systèmes de nuages de GEWEX;

3) mesures sur le terrain et expérimentales de noyaux de condensation des nuages, de l'activation des aérosols et de la grosseur des gouttelettes.

Qualité de l’air et chimie de l’atmosphère – de l’espace à la couche limite

Jack McConnell - Université York
Contact: jack@nimbus.yorku.ca

Les données sur la composition de l’atmosphère recueillies à partir de l’espace constituent une composante de plus en plus importante des aperçus globaux sur la composition changeante de l’atmosphère du point de vue de la qualité de l’air et du climat. Ces données présentent une perspective plus large par rapport à ce qui pourrait être obtenu des stations au sol ou d’un avion. Les instruments d'observation en visée nadir des spectres visibles et en proche infrarouge (NIR), comme les spectromètres SCIAMACHY et GOME, entres autres, peuvent mesurer les colonnes atmosphériques de gaz dans la troposphère et la stratosphère, tandis que les instruments à infrarouge moyen, comme MOPITT, mesurent des colonnes partielles de CO. Des instruments d’observation du limbe, comme ACE-FTS, MAESTRO, MIPAS et OSIRIS, fournissent des mesures selon la hauteur sur la qualité de l’air et sur les gaz et aérosols liés aux climat, jusque dans la haute troposphère. De plus, les instruments imageurs, comme MODIS et MERIS, fournissent non seulement des données sur l’utilisation des sols et la température de la surface, mais aussi sur le feu en milieu boréal, la profondeur optique des aérosols et, dans le cas de MERIS, les propriétés des aérosols. Ces données ont pour parfait complément les réseaux AERONET, AEROCAN et EC CORAL. Nous invitons les chercheurs qui effectuent des études sur la qualité de l’air dans la troposphère et en haute troposphère et en basse stratosphère (HTBS) à présenter leurs travaux. Nous nous intéressons particulièrement aux travaux qui intègrent les données satellites pour analyser la qualité de l’air à l’échelle régionale et globale, les études en HTBS, les études sur le feu (combustion de biomasse) et les six études APPOC qui seront présentées par le PCW. De plus, nous encourageons les chercheurs à faire des études de modélisation et d’assimilation des données chimiques ainsi que des comparaisons entre les données tirées de l’équipement au sol et des satellites afin de faire ressortir, si possible, la synergie entre les mesures provenant des stations au sol, des avions et des satellites.

Haute troposphère et basse stratosphère (HTBS)

Michel Bourqui - Université McGill
David Tarasick - Environnent Canada
Contact: michel.bourqui@mcgill.ca

La haute troposphère et la basse stratosphère représentent une région importante de l’atmosphère, puisqu’elles régissent les échanges entre ces deux parties de l’atmosphère. Cette région a une incidence importante sur la composition de la troposphère et de la basse stratosphère et constitue un domaine de recherche important.

Pour cette séance, on cherche des travaux sur tout ce qui entoure la haute troposphère et la basse stratosphère, y compris les effets des échanges entre la stratosphère et la troposphère sur la composition de l’atmosphère. Les études dans lesquelles on utilise des observations, comme les mesures par ballon, ou les satellites, ou encore une combinaison d’observations et de modélisations numériques, sont particulièrement souhaitées.

Météorologie aéronautique

Stewart Cober - Section de la physique des nuages et de la recherche sur les phénomènes météorologiques violents
Contact: stewart.cober@ec.gc.ca

Cette séance comprendra une série d'exposés en lien avec la météorologie aéronautique. On pourrait traiter de diverses questions relatives à la science et aux services de météorologie pour l'aviation, y compris les stratégies de prévision d'aérodrome (TAF), les prévisions d'aéroports-pivots, le givrage des aéronefs, les problèmes opérationnels, les besoins de la clientèle, les nouvelles applications de R et D, les applications NinJo, les études de cas et les questions émergentes. On a déjà tenu des séances semblables fort réussies au cours de congrès précédents de la SCMO. Je me porte volontaire pour organiser l'ensemble de la séance, examiner et organiser les résumés et trouver des gens qui accepteront de diriger les sous-séances. J'inciterai des représentants du gouvernement, d'universités et du domaine de l'aviation à participer.

Les Jeux olympiques et paralympiques d'hiver de Vancouver 2010

George Isaac, Paul Joe
Section de la recherche sur la physique des nuages et du temps violent, Environnement Canada
Contact: george.isaac@ec.gc.ca

Les Jeux olympiques et paralympiques d'hiver de Vancouver 2010 étaient une excellente occasion d'améliorer notre capacité à fournir des prévisions météorologiques en terrain complexe. Les problèmes associés à la mesure en région montagneuse des paramètres météorologiques critiques, entre autres les vents, les précipitations et la visibilité, ont été réglés. Plusieurs nouveaux modèles numériques et nouvelles méthodes connexes ont été élaborés et évalués. Des efforts internationaux, comme les projets SNOW-V10 (Science of Nowcasting Olympic Weather in Vancouver 2010 [Science en matière de prévisions météorologiques immédiates pendant les Jeux olympiques de Vancouver 2010]) et T-Parc (THORPEX Pacific Asia Regional Campaign [Campagne régionale THORPEX Asie-Pacifique]) ont également été déployés en association avec les Jeux olympiques d'hiver. On demande au milieu de la recherche et à la communauté opérationnelle de présenter des soumissions concernant de telles activités.

Nos routes – Le point sur la météorologie routière

Paul Delannoy
Contact: paul.delannoy@amec.com

Presque tous les gouvernements provinciaux et territoriaux du Canada ont maintenant installé un réseau de stations météo routières (SMR). Depuis que le gouvernement fédéral a créé son programme de soutien SMR Canada en 2002, le nombre de SMR a augmenté de manière spectaculaire partout au pays et dépasse maintenant les 400 stations. Afin de faciliter la tâche aux préposés à l'entretien routier hivernal, les entreprises du secteur privé utilisent les données des SMR pour prévoir la température de la surface du revêtement en des points qui servent de repères essentiels. Ces services ont prouvé leur utilité pour améliorer la sécurité routière tout en réduisant la quantité de sel utilisé et les coûts inhérents. On crée actuellement de nouvelles applications avec toutes ces données. Cela comprend le recours à l'imagerie infrarouge pour obtenir des données sur toute la longueur de la route entre les SMR et prévoir le profil vertical des températures sous la route afin de déterminer avec précision à quel moment il faut appliquer des restrictions de poids. Des aides à la décision ont été créées pour réduire l'important volume de données météorologiques complexes afin que le personnel d'entretien puisse facilement les comprendre et les appliquer. La majorité des autorités utilisent aussi des sondes (infrarouge pour la température du revêtement, la température de l'air et l'humidité relative) à bord de leurs véhicules de patrouille et/ou de leurs charrues. La position et l'activité des véhicules sont suivies de près à l'aide de GPS et de communications cellulaires. De nouvelles applications sont créées à partir de ces données en temps réel provenant de l'ensemble du réseau. Aux É.-U., le National Center for Atmospheric Research, grâce à un financement pluriannuel de la Federal Highways Administration, a mis sur pied le Maintenance Decision Support System (système d'aide à la prise de décisions pour l'entretien), lequel intègre diverses données météorologiques et procure des produits pour guider les décisions relatives à l'ensemble du réseau routier. De riches ensembles de données météorologiques routières, dont la plus grande partie est partagée avec EC grâce à des accords de partage des données conclus dans le cadre du programme SMR Canada, seront bientôt appliqués afin de fournir de l'information encore plus utile à d'autres groupes, comme les usagers de la route, grâce à de nouveaux services novateurs comme la ligne téléphonique 511 donnant les conditions routières et météorologiques. La ligne 511 est déjà en fonction au Québec, en Nouvelle-Écosse et au Yukon.

Éruption de tornades du 20 août 2009 en Ontario

Arnold Ashton - Environnent Canada
Contact: Arnold.Ashton@ec.gc.ca

L'été 2009, l'Ontario a connu une saison des tornades frisant les records, avec un total de 27 tornades entre avril et septembre. Les tornades ont causé quatre décès et des dommages sans précédent dans toute la province. Le point culminant de la saison fut le 20 août, lorsqu'une grande éruption a lancé 17 tornades sur le sud de l'Ontario (ce qui en a fait l'une des plus grandes éruptions de tornades jamais enregistrées au Canada), causant un décès et de graves dommages à plusieurs endroits. Un examen détaillé de cet événement et une comparaison avec d'autres épisodes de vents violents ou de tornades permettront d'améliorer nos programmes de prévision et d'avertissement et de mettre en commun nos connaissances avec d'autres centres de prévision. Un certain nombre de communications seront présentées. Citons notamment une analyse approfondie de la configuration météorologique synoptique en présence c jour-là, y compris l'examen attentif d'un certain nombre de paramètres météorologiques jugés importants dans la genèse des tornades (énergie convective potentielle disponible, hélicité, cisaillement effectif). L'événement sera comparé avec d'autres épisodes venteux, y compris un derecho survenu sur le sud de l'Ontario le 9 août. Une analyse structurelle détaillée des tempêtes enregistrées par radar sera présentée, et abordera notamment la signature radar des débris volants dans les environs de Toronto. La grande ampleur de l'événement du 20 août et son effet sur une zone urbaine nous procurent une rare occasion d'examiner en détail, dans une perspective d'ingénierie, les dommages causés par les tornades (par l'équipe de recherche en ingénierie de l'Université de l'Ouest de l'Ontario). Nous aurons probablement aussi un aperçu des conceptions structurales climatiques (Division de recherche en adaptation environnementale, Environnement Canada). Nous pourrons aussi inclure un examen de la couverture médiatique afin de juger de la réaction des Canadiens aux avertissements de temps violent. La séance comptera au total six ou sept communications. (Pour information : on étudie actuellement la possibilité qu'il y ait eu une 18e tornade le 20 août; si cette tornade est confirmée, elle fera de cette éruption de tornades la plus importante jamais enregistrée en Ontario (et peut-être au Canada).

Énergie éolienne

Peter Taylor - Centre de recherche en sciences de la Terre et spatiales, Université York
Jim Salmon - Zephyr North Canada
Contact: pat@yorku.ca

Étant donné l'augmentation de la population et de la consommation d'énergie, les préoccupations de plus en plus importantes entourant le changement climatique, la sûreté et les coûts en ce qui concerne l'énergie nucléaire et les ressources limitées en pétrole et en gaz, la majorité des pays prévoient une augmentation importante de leur utilisation de l'énergie éolienne et solaire pour la production d'électricité. Au Canada, on vise une augmentation de 1% aujourd'hui à 20% d'ici 2030.

L'atmosphère joue un rôle central pour ces sources d'énergie renouvelable. L'évaluation des ressources et les prévisions propres au site (vent et rayons solaires pour une période de 24 à 48 heures) sont les principaux domaines où l'on a recours à la météorologie. Toutefois, pour l'énergie éolienne, l'atmosphère joue aussi un rôle pour ce qui est, par exemple, de la propagation du bruit et des risques de givrage. La turbulence et le cisaillement du vent peuvent causer des problèmes aux grosses éoliennes et les effets de sillage dans les parcs éoliens nécessitent des recherches supplémentaires.

Prévisions d'ensemble : applications actuelles et émergentes

Bertrand Denis, Lewis Poulin - Centre météorologique canadien
Contact: lewis.poulin@ec.gc.ca

Une session est proposée pour discuter de l'impact des systèmes de prévision d'ensemble (SPE) sur un nombre croissant de domaines d'activités de prévision. Les présentations portant sur les produits de prévisions d'ensemble sont les bienvenus. Par exemples, les produits utilisés pour la planification et la gestion de risque dans les secteurs tels que : prévisions météorologiques gouvernementales et commerciales, demande et production énergétique (incluant les énergies renouvelables), hydrologie, recherche et sauvetage, gestion des opérations forestières (feux de forêt), finances et assurances, réponses gouvernementales aux urgences, etc. Il y a également un intérêt pour les présentations montrant comment l'augmentation de nos connaissances dans le domaine des prévisions d'ensemble peut nous aider dans nos stratégies d'adaptation et d'atténuation des changements climatiques.

Les présentations concernant les modèles et les techniques SPE présentement utilisés ou qui le seront sous peu dans les centres nationaux et régionaux de prévisions météorologiques sont également les bienvenus. Les présentations reliées au système de prévision d'ensemble Nord-Américain (SPENA) ainsi que sur d'autres projets basés sur des données SPE vont servir à familiariser les utilisateurs à ce nouveau type d'ensemble de données. La diversité des thèmes des présentations va intéresser les météorologistes-prévisionnistes opérationnels mais aussi les prévisionnistes des autres secteurs qui dépendent de la météorologie et de l'environnement. Cette session mettra en évidence comment l'utilisation des SPE et de leurs produits est en train de redéfinir notre façon de faire les prévisions.

CLIMAT

Les processus stratosphériques et leur incidence sur le climat

Norman McFarlane - SPARC IPO, Université de Toronto
Theodore Shepherd, Paul Kushner - Département de physique, Université de Toronto
Saroja Polavarapu - Environnent Canada
Contact: Norm.Mcfarlane@ec.gc.ca

Cette séance traitera essentiellement de sujets en rapport avec le programme Processus stratosphériques et leur rôle dans le climat (SPARC) du Programme mondial de recherche sur le climat (PMRC), y compris de questions de portée générale touchant directement au PMRC et étroitement liées aux activités présentes du programme SPARC. Les thèmes prioritaires du SPARC sont le couplage chimie-climat, le couplage dynamique stratosphère-troposphère, et la détection, l'attribution et la prévision des changements stratosphériques. Ses éléments essentiels sont notamment l'assimilation des données stratosphériques, la validation axée sur les processus des modèles chimie-climat, les ondes de gravité, la variabilité dynamique du couple stratosphère-troposphère et les études en laboratoire. La séance portera sur la chimie et la dynamique de l'atmosphère, de la troposphère supérieure à la mésosphère, et accordera une place de choix aux aspects intégrateurs et couplés dont les importants processus de couplage stratosphère-troposphère qui influent sur le système et sur les changements climatiques. Elle comportera plusieurs exposés oraux de conférenciers invités issus du milieu scientifique international associé au SPARC en plus d'autres exposés oraux et par affiches.

Le changement climatique et les évènements extrêmes

Chad Shouquan Cheng - Environnent Canada
Contact: shouquan.cheng@ec.gc.ca

Le fait est reconnu largement que sous les changements climatiques, la fréquence des hasards météorologiques et hydrologiques extrêmes et le coût des dommages associés devraient augmenter au 21ième siècle. Afin d'augmenter la capacité d'adaptation pour minimiser le risque des hasards futurs, l'information scientifique solide sur les estimés d'hasards extrêmes futurs est essentielle pour les chefs d'organisation comme outil servant au développement des politiques et de stratégies d'adaptation. Cette information inclut les évaluations quantitatives sur les changements dans la fréquence et la grandeur des hasards météorologiques extrêmes et hydrologiques avec le climat du futur. Cette session invites les soumissions de papiers concernant les impacts du changement climatique sur les hasards météorologiques et hydrologiques extrêmes en utilisant ldes sorties de MCG, MCR et/ou les scénarios de diminutions statistiques. Les hasards météorologiques/ hydrologiques incluent, mais sans limitation des autres sujets, chaleur, froid, forte chute de pluie, inondation, sècheresse, pluie verglaçante, rafale de vent, ouragan, tornade, etc. Le but de cette session est de procurer une plate-forme pour les chercheurs afin de partager l'information, échanger les développements récents et les applications des analyses des impacts du changement climatique sur les météorologiques et hydrologiques extrêmes.

Le cycle du carbone et les changements climatiques

Nathan Gillett, Kirsten Zickfeld - CCCma, Environment Canada

Damon Matthews - Géographie, planification et environnement, Université Concordia
Contact: nathan.gillett@ec.gc.ca

Les cycles du carbone marin et terrestre sont des déterminants importants de la future teneur en CO2 de l'atmosphère et, par conséquent, des changements climatiques. On s'attend à ce que le cycle global du carbone change en raison à la fois des concentrations élevées de CO2 dans l'atmosphère et des changements climatiques, et les incertitudes à cet égard sont grosso modo aussi importantes pour la prévision des changements climatiques au 21e siècle que celles que présente le système climatique physique. Les cycles interactifs du carbone terrestre et du carbone océanique sont maintenant intégrés dans de nombreux modèles climatiques de pointe, y compris le modèle canadien CanESM2, ce qui procure de nouveaux outils puissants pour étudier ces questions. Des recherches récentes ont mis en lumière le caractère irréversible du changement climatique induit par le CO2 sur des échelles de temps de cent ans, le fait que les changements de température induits par le CO2 ne dépendent pas de la voie d'émission (path?independence) du CO2 mais de la quantité totale émise et les implications qui en découlent pour les politiques. Nous sollicitons des propositions sur tous les aspects du cycle global du carbone et ses interactions avec les changements climatiques.

Variabilité et prévisibilité à basse fréquence

Hai Lin, Bin Yu - Environnent Canada
Contact: hai.lin@ec.gc.ca

Pour cette séance, on souhaite avoir des contributions qui concernent la variabilité du climat et les prévisions climatiques pour les échelles intrasaisonnière, interannuelle et décennale-interdécennale. On cherche des travaux sur divers sujets, comme des études de l'oscillation Madden-Julian et des vagues tropicales, du phénomène El Niño/oscillation australe (ENSO), des configurations de la circulation atmosphérique, des téléconnexions, des interactions air-mer et tropicale-extratropicale et des effets de ces processus sur la prévisibilité et les prévisions relatives au climat. On cherche aussi des travaux relatifs à des prévisions météorologiques étendues et à long terme et des prévisions de la variabilité du climat à diverses échelles de temps, ce qui englobe les techniques de prévision d'ensemble et d'initialisation, l'élaboration de modèles, l'évaluation des capacités de prévision, la mise à l'échelle inférieure et l'étalonnage, de même que la valeur et les applications pour l'utilisateur final. On souhaite aussi avoir des résultats de diagnostics, de modélisations, de comparaisons de modèles et de stratégies théoriques.

Modélisation régionale du climat

Laxmi Sushama, René Laprise - Université de Québec à Montreal
Ramon De Elia - Consortium Ouranos
Bernard Dugas - RPN, Environnent Canada
Contact: sushama.laxmi@uqam.ca

Les modèles climatiques régionaux (MCR) sont de plus en plus employés pour étudier les processus climatiques à petite échelle et pour mettre les résultats des modèles climatiques mondiaux (MCM) à une échelle inférieure (résolution spatiale plus élevée). On cherche des présentations qui fourniront un aperçu de l'état actuel des réalisations dans les MCR dynamiques et un résumé des questions en suspens concernant l'élaboration et l'application des MCR. On souhaite avoir de l'information sur les sujets suivants (entre autres) : mise à l'échelle régionale des scénarios de changement climatique du GIEC, projets de comparaison de MCR, conception des simulations des MCR tenant compte des besoins des études sur les effets du climat, influence de la résolution et de la paramétrisation physique sur la précision des MCR, évaluation de l'incertitude associée aux projections régionales, évaluation de la capacité de réaliser la mise à l'échelle inférieure et évaluation de la valeur ajoutée et des capacités des MCR lorsque l'on applique ceux?ci à des régions différentes.

INTERACTION ATMOSPHÈRE-OCÉAN
Séance Lawrence Mysak sur la dynamique des océans et du climat

William Hsieh - Département des sciences de la Terre et d'océanographie, Université de la Colombie-Britannique, Vancouver, BC, V6T 1Z4
Bruno Tremblay - Département des sciences atmosphériques et d'océanographie, Université McGill, Montréal, Qc., H3A 2K6
Contact: whsieh@eos.ubc.ca

On prévoit une séance spéciale visant à souligner la carrière du professeur Lawrence Mysak. Le professeur Mysak a d'abord travaillé en océanographie dynamique, notamment sur la dynamique des vagues à basse fréquence et les processus liés aux plateformes continentales. Plus tard, il s'est intéressé à la dynamique du climat et à la modélisation du système océan-glace-atmosphère, de la variabilité du climat actuel au paléoclimat. Il entend poursuivre ses activités professionnelles et de recherche à titre de professeur émérite à l'Université McGill. On souhaite obtenir des résumés sur la dynamique des océans et du climat, de même que sur tous les aspects du travail du professeur Mysak (exposés oraux, affiches). La séance se tiendra dans le cadre d'un déjeuner le mardi 1er juin durant lequel les amis du professeur Mysak se réuniront pour lui souhaiter bonne chance (les billets pour le déjeuner seront offerts au moment de l'inscription).

Dynamiques de l'atmosphère, de l'océan et du climat

Adam Monahan - Université de Victoria
Marek Stastna - Université de Waterloo
Ron Mctaggart- Cowan- Environnent Canada
Contact: monahana@uvic.ca

Cette séance assemble les soumissions orientées vers les dynamiques de l'atmosphère de l'océan et du climat. Le titre est intentionnellement vaste afin de permettre aux chercheurs qui se concentrent sur l'étude de n'importe quel aspect du système terrestre à partir de perspective dynamique de joindre la session. D'autres séances existent pour adresser les sujets opérationnels, la modélisation numérique et l'acquisition, et l'utilisation des observations. Cependant, les études dynamiques et diagnostiques des systèmes atmosphère-océan et les systèmes climatiques sont souvent difficiles à placer dans des séances particulières. Des études théoriques et de l'analyse des prévisions, le climat et les modèles de processus et de réanalyse et d'autres servent de données d'observation de la précieuse fonction de plus en plus notre compréhension de la dynamique importante et thermodynamique des processus qui conduisent les circulations à travers les échelles temporelles et spatiales. Une session bien organisée qui consisterait d'études abordant le sujet de ce point de vue serait d'un grand bénéfice pour la communauté météorologique et océanographique canadienne.

Interaction atmosphère-océan et les vagues

Will Perrie - Pêches et Océans Canada
Contact: perriew@dfo-mpo.gc.ca

Cette session explorera les dynamiques des vagues extrêmes, les courants induits par la tempête, et les ondes de tempête produites par les ouragans sévères. Les processus de couplage seront également considérés. Par exemple, dans une atmosphère couplée – vague-embrun-système de modèle courant, les effets d'embrun et traîné de la vague ont un impact sur les vagues générées par la tempête, la variation de leurs hauteurs et la direction du spectre de la vague reliée à la position et la vitesse de déplacement de la tempête. La diminution ou l'augmentation de la hauteur de la vague significative causée par l'embrun et la traînée est plus significative dans les régions des vents forts à la droite de la trajectoire de la tempête. Ces processus sont modulés dans la région de la vague maximum et ils ont tendance à se produire après l'évènement des vents maximum dépendant de la vitesse de translation de la tempête. La vitesse de translation de la tempête est importante. La variation directionnelle entre les vents locaux et les vagues générées par le vent à l'intérieur des tempêtes à mouvement rapide qui dépassent le groupe de vagues est notamment différente de la situation où les vagues sont trappées. Les vagues sont trappées lorsque la vitesse de groupe des vagues dominantes est approximativement équivalente à la vitesse de translation de la tempête. Ces processus ont un impact sur les courants océaniques et les ondes de tempête. Les transferts de momentum du vent à la vague et de la vague au courant ont pour effet total de réduire la vitesse des courants de surface. Nous invitons des présentations sur d'autres aspects des systèmes de couplage atmosphère-océan ainsi que les simulations des tempêtes marines.

Prévision et prévisibilité avec modèles couplés atmosphère-océan

Keith Thompson - Université Dalhousie
Hal Ritchie - Environnent Canada/Université Dalhousie
William Merryfield - Environnent Canada/ Université de Victoria
Contact: psc@cmos.ca

On observe un intérêt accru chez les scientifiques pour améliorer et élargir les capacités des modèles couplés atmosphère-océan-terre-glace de mer sur des échelles de temps allant de quelques jours à quelques décennies. Il est généralement admis que cela exige la création de modèles couplés atmosphère-océan et de systèmes d'assimilation, bien que l'initialisation d'un modèle terre-glace de mer présente aussi des difficultés et des possibilités et fasse l'objet d'une attention accrue. Le progrès dans ce domaine repose sur la mise au point de méthodes pour assimiler les données d'observation dans des modèles couplés, de même que sur la détermination et la compréhension des processus physiques qui limitent ou favorisent la prévisibilité. Tous les chercheurs intéressés sont invités à proposer une communication sur des questions de science, de modélisation et d'assimilation liées à la prévision et à la prévisibilité du système couplé atmosphère-océan-terre-glace de mer.

Quand l'atmosphère et l'océan font bon ménage sur le Golfe du Saint-Laurent

Serge Desjardins - Environnement Canada
Contact: serge.desjardins@ec.gc.ca

Voilà plus d'une décennie maintenant que la région du Golfe du Saint-Laurent est sujette d'études ayant pour but la compréhension et la modélisation de l'interaction atmosphère-océan. Le système de prévision couplé du Golfe du Saint-Laurent d'Environnement Canada est un exemple des retombées scientifiques des ces activités de recherche et développement. Ce système est le fruit de collaborations entre divers groupes de R&D : Institut Maurice-Lamontagne (IML), Recherche en Prévision Numérique, Centre Météorologique Canadien (CMC), UQAR, le Service Canadien des glaces, etc. Son développement a eu au fil des années des ramifications en R&D telles que l'inclusion de la glace dans les prévisions de vagues et l'assimilation de données des glaces. Finalement, il est souvent vu comme la première étape franchie dans le développement de systèmes couplés plus complexes multi-échelles tel CONCEPTS.

Cette session sera consacrée aux études météorologiques et océanographiques faites en mode couplées ou non, ainsi qu'à tout autre domaine de recherche connexe tel que la prévision des vagues, des glaces, et de l'assimilation de données sur la région du Golfe du Saint-Laurent.

Nous dédions cette session à Dr. François Saucier qui, par le développement du modèle océanique de l'IML et par ses études de l'océanographie physique de la région, a permis le développement de la modélisation couplé atmosphère-océan du Golfe du Saint-Laurent.

OCÉANOGRAPHIE

Séance générale sur l'océanographie

Guoqi Han - Pêches et Océans Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

Cette séance comprendra des communications sur les sciences de l'océanographie qui ne conviennent pas bien aux autres séances sur l'océanographie.

L'Acoustique dans l'océanographie

Tetjana Ross - Université Dalhousie
Contact: tetjana@dal.ca

Le point de cette session est de souligner les contributions de l'acoustique sous-marine à l'océanographie. Cela inclut, mais sans limitation, les études menées sur le sonar et l'acoustique passif, le bioacoustique, la structure géologique dans le fond de l'océan, la communication acoustique, les applications navales, le bruit ambiant, la propagation de longue distance, la dispersion de haute fréquence, la production d'image et l'inversion quantitative.

Océanographie opérationnelle : observations, modélisation et assimilation des données

Greg Smith - Environnent Canada
Denis Gilbert, Fraser Davidson, Howard Freeland - Pêches et Océans Canada
Contact: Gregory.Smith@ec.gc.ca

On entend, par océanographie opérationnelle, la transformation d'observations individuelles de l'océan en analyses et en prévisions utiles et régulières (pas toujours en temps réel) de l'état de l'océan. Pour effectuer des analyses utiles, il faut des observations, des modèles et des systèmes d'assimilation des données. Pour cette séance, on souhaite avoir des affiches et des exposés sur tous les aspects de l'océanographie opérationnelle, qu'il s'agisse de l'analyse des systèmes d'observation (p. ex., Argo) et des satellites, de la modélisation de l'océan ou de l'assimilation des données. On aimerait également avoir des études sur les applications pratiques des systèmes de prévisions océanographiques, y compris les systèmes intégrés de prévision atmosphère-océan-glace.

Observatoires océaniques : en ligne et opérationnels

Richard Dewey - VENUS, Université de Victoria
Mairi Best - NEPTUNE Canada, Université de Victoria
Contact: rdewey@uvic.ca

Cette séance portera essentiellement sur les nouvelles possibilités offertes par les observatoires océaniques sur le plan de la science, de l'ingénierie, de l'éducation et de la sensibilisation. Avec ses observatoires océaniques câblés VENUS et NEPTUNE aménagés au large de la côte ouest du pays, le Canada fait figure de chef de file mondial dans ce nouveau domaine de la recherche océanique interactive en temps réel. D'autres observatoires de l'Arctique, du Saint-Laurent et des Maritimes témoignent aussi de l'expertise et de l'approche novatrice du Canada sur diverses plateformes reliées en réseau. Des projets d'envergure internationale de construction d'observatoires océaniques aux États-Unis, en Europe et en Asie sont aussi en cours. Nous invitons les personnes intéressées à soumettre des projets de communication en rapport avec tous les aspects de la recherche en observatoire océanique, y compris les études axées sur les processus, la surveillance à long terme, la modélisation et l'assimilation des données, les solutions d'ingénierie, les instruments mis en réseaux, le maniement des données et la distribution de produits opérationnels.

Océanographie côtière et les eaux intérieures

Ram Rr Yerubandi - Environnent Canada/ NWRI
Jinyu Sheng - Université Dalhousie
Guoqi Han - Pêches et océans Canada
Contact: ram.yerubandi@ec.gc.ca

Cette session va considérer tous les aspects depuis les systèmes d'observations jusqu'à la modélisation numérique des processus physiques et biochimiques dans les domaines côtiers, les mers continentales, les estuaires et les eaux intérieures. Les sujets incluent l'océanographie physique côtière, les ondes de tempêtes, les tsunamis, les dynamiques d'estuaires, l'hydrologie et l'hydrodynamique des grands lacs, les interactions terre-lac et le mélange et la dispersion des matériaux. Nous invitons aussi les contributions reliées aux observations et à la modélisation biochimique dans les eaux côtières et intérieures.

Changements et variabilité du climat océanique et leurs effets

John Loder - Pêches et océans Canada, Institut océanographique de Bedford
Ken Denman, Mike Foreman - Pêches et océans Canada, Institut des sciences de la mer
Contact: John.Loder@dfo-mpo.gc.ca

L'océan est un élément majeur du système climatique de la Terre. Le changement et la variabilité du climat des océans peuvent influer de façon importante sur les écosystèmes marins, les populations côtières et les activités maritimes, tant à l'échelle mondiale que régionale. Cette séance portera sur les changements récents (tendances) et la variabilité (fluctuations) et leurs effets combinés sur les océans canadiens, de même que sur les changements et la variabilité futurs, projetés ou potentiels, et leurs effets. Ces effets peuvent se faire sentir sur les systèmes climatiques régionaux ou mondiaux, le climat océanique côtier, les écosystèmes marins, les zones côtières et/ou diverses activités relatives à l'océan. Nous souhaitons entendre des communications sur les trois océans qui entourent le Canada, mais comme on s'attend à ce qu'il y ait des communications sur l'océan Arctique dans d'autres séances, l'accent pourrait être mis pour cette séance sur le nord-est du Pacifique et le nord-ouest de l'Atlantique. Nous aimerions notamment avoir des communications sur des études physiques et biogéochimiques portant sur les changements et la variabilité du climat océanique et ses effets.

Téléobservation des océans
Gary Borstad, Howard Edel - ASL Environmental Sciences
Contact: edel@dfo-mpo.gc.ca

La téléobservation de la vaste zone côtière du Canada et de ses zones océaniques continue à progresser et à donner naissance à des applications opérationnelles, les détecteurs et systèmes de traitement des données convergeant pour fournir en temps opportun et de manière rentable des données quantitatives sur les conditions marines. En combinant des méthodes qui comprennent l'utilisation de données de téléobservation dans les modèles, on améliore les possibilités de prévision et la précision des prévisions immédiates. La surveillance de la vaste zone économique exclusive au Canada se trouve améliorée par la grande variété des systèmes de téléobservation. Les programmes canadiens RADARSAT 1 et 2 sont destinés à fournir un système d'observation spatial visant les besoins en matière de surveillance propres à la région polaire et si importants pour le développement nordique; ils favoriseront le développement économique des régions nordiques et permettront d'en améliorer l'accès, en plus de permettre au Canada d'exercer sa souveraineté. Cette séance portera sur les systèmes d'observation actifs et passifs que les spécialistes du climat marin et les utilisateurs opérationnels utilisent pour surveiller la zone côtière et l'environnement marin, de même que les navires dans la zone économique exclusive au Canada.

Réactions biogéochimiques de l'océan aux changements environnementaux
Helen Joseph, Paul Lyon - Pêches et Océans Canada
Contact: Helen.Joseph@dfo-mpo.gc.ca

Les changements environnementaux mondiaux, régionaux et locaux ont de profondes conséquences socio-économiques. L'acidification des océans, la fertilisation, l'eutrophisation, l'hypoxie, etc., peuvent altérer les structures communautaires et les réseaux trophiques de l'océan côtier et de la haute mer, entraînant la dégradation des écosystèmes et des pêches. Nous sollicitons des communications sur des travaux dans le domaine de la biogéochimie qui décrivent des observations sur le terrain, des expériences en laboratoire, des études paléo-océanographiques et des études de modélisation portant sur les océans septentrionaux.

INTERDISCIPLINAIRE
Conditions météorologiques et climat : effets sur la santé
Denis Bourque - Environnent Canada
Contact: denis.bourque@ec.gc.ca

Les séances s'inscrivant dans ce thème offrent la chance de présenter des travaux originaux concernant la relation entre les conditions météorologiques ou le climat et la santé humaine, notamment les travaux qui traitent du climat ou du changement climatique et des questions relatives à la santé; des conditions météorologiques et des questions relatives à la santé; des produits et programmes opérationnels concernant la santé liés aux conditions météorologiques; des questions d'ordre politique ou économique entourant les conditions météorologiques et le climat et leur incidence sur les questions relatives à la santé. On souhaite avoir des travaux originaux portant sur la relation entre la santé humaine (mentale et physique) ou les systèmes de santé de la société et le climat actuel ou futur, ou sur la relation entre la santé humaine (mentale et physique) ou les systèmes de santé de la société et les conditions météorologiques quotidiennes actuelles ou futures. On aimerait également avoir des travaux sur les produits et services opérationnels concernant la santé liés aux conditions météorologiques, comme les indices de refroidissement éolien et de chaleur et le programme contre la maladie pulmonaire obstructive chronique (MPOC) du Met Office (Royaume-Uni). On invite également à soumettre des études météorologiques sur les maladies humaines à transmission vectorielle ou leurs porteurs, comme les tiques (maladie de Lyme) et les moustiques (virus du Nil occidental) ou sur les bactéries (p. ex., E. coli 0157:H7, campylobactéries et cryptosporidies).

La météo et la société – Études intégrées

Jacques Descurieux, Rebecca Wagner - Environment Canada/Service météorologique du Canada
Contact: jacques.descurieux@ec.gc.ca

Cette session vise à rassembler des praticiens, des chercheurs, et les membres participants, dans tous les secteurs de l'entreprise météo, qui se consacrent à l'intégration de la météorologie et des sciences sociales. Il devrait se former un forum qui facilite l'intégration complète et durable des sciences sociales dans la recherche et l'application météorologique. L'objectif est de procurer à la communauté météorologique un moyen de connaître et d'examiner davantage les idées, les méthodes et les exemples liés à l'intégration du travail météo-société.

Cette session s'adresse aux articles explorant les nouvelles approches pour étudier le temps, le climat, et la société. Cela comprend, mais sans limitation :

· Méthodes qualitatives et quantitatives pour améliorer la compréhension, la communication, et l'utilisation de l' information provenant des études d'impacts météorologiques et climatiques · Méthodes mixtes et études d'impact comparatives qualitatives · Les sujets de risques et problèmes de communication reliés à la météo dangereuse · Communiquer l'incertitude et les prévisions · Enjeux de perception de risque et de choix reliés à météo dangereuse · Croisement des avertissements, et de la gestion des réactions et des situations d'urgence · Recherche dans l'atténuation, la préparation et la durabilité.

L'eau, la météo et le climat au service du secteur énergie

Anne-Marie Valton - Environnent Canada
Contact: anne-marie.valton@ec.gc.ca

L'énergie devient de plus en plus un enjeu tout aussi important que les changements du climat et l'état de l'eau. Il y a un besoin mondial de traiter cet enjeu dans le contexte des changements climatiques. Nous avons besoin de trouver des manières de gérer la demande et la disponibilité de l'énergie de façon plus efficace. La prévision environnementale dans la science de l'atmosphère et de l'eau peut adresser directement ces importantes priorités en aidant les décideurs à améliorer la gérance des ressources énergétiques. Elles aident aussi à assurer l'égalité entre la quantité de la ressource et la demande d'énergie et à mieux gérer le risque sur l'infrastructure énergétique. Elles peuvent améliorer l'inventaire des gaz à effet de serre ainsi qu'à évaluer le potentiel des ressources renouvelables. Les prévisions environnementales peuvent améliorer la compétitivité et le leadership d'un système énergétique net. Puisque le Canada est parmi un des plus grands producteurs au monde de tous les types d'énergie, il est important de supporter ce secteur et montrer que nous pouvons aider ceux et celles qui prennent les décisions dans ce domaine.

Prévisions environnementales pour les villes canadiennes

James Voogt - Université de l'ouest de l'Ontario
Tim Oke - Université de la Colombie Britannique
Contact: javoogt@uwo.ca

Cette séance vise à présenter les résultats du réseau Environmental Prediction in Canadian Cities (EPiCC), un projet de la FCSCA. En juillet 2010, cela fera quatre ans que les recherches du réseau EPiCC seront commencées; la réunion de la SCMO se tiendra donc à un moment qui permettra aux membres du réseau EPiCC de présenter aux participants les résultats des principaux volets du projet EPiCC. Cela comprend les observations à long terme du bilan énergétique et du flux de carbone dans quatre zones urbaines à Montréal et à Vancouver, auxquelles on a ajouté des observations à court terme permettant d'examiner le rôle du manteau nival et de l'irrigation à Montréal et à Vancouver, respectivement. On s'est principalement penché sur les zones résidentielles de villes qui représentent une grande partie des zones urbaines et qui combinent l'environnement bâti à une végétation importante. On complète les observations à la surface avec des observations au moyen de célomètre, de lidar et d'appareils emportés par ballon de la couche limite urbaine de Vancouver afin de mieux comprendre son évolution dans l'espace et le temps. La modélisation du réseau EPiCC a pour objectif de fournir une paramétrisation de la surface urbaine pouvant être intégrée au système de prévisions du SMC pour fournir de meilleures prévisions météorologiques dans les zones urbaines canadiennes. Pour la modélisation, on élabore un plan de paramétrisation de la surface urbaine s'appuyant sur le modèle Town Energy Balance (TEB) de Masson (2000). Ce modèle a été modifié afin de représenter de façon adéquate les conditions observées dans les villes canadiennes et ses résultats font actuellement l'objet d'une comparaison avec l'ensemble de données d'observation du réseau EPiCC. On s'attend à ce que des chercheurs du réseau fassent entre six et huit présentations, dans lesquelles ils décriront les résultats d'EPiCC qui sont représentatifs de la combinaison des activités d'observation, de modélisation et de télédétection. Si on le souhaite, on pourrait ajouter d'autres travaux portant sur le climat urbain.

Micrométéorologie des écosystèmes canadiens

Paul Bartlett - Division de la recherche climatique, Environnement Canada
Elyn Humphreys - Département de géographie et d'études environnementales, Université Carleton
David Spittlehouse - Direction de la recherche, British Columbia Ministry of Forests and Range
Ralf Staebler - Division sur la recherche de la qualité de l'air, Environnement Canada
Jon Warland - École des sciences de l'environnement, Université de Guelph
John Wilson - Département des sciences de la terre et de l'atmosphère, Université de l'Alberta
Contact: Paul.Bartlettt@ec.gc.ca

Le paysage terrestre canadien se compose d'une variété d'écosystèmes qui sont habituellement caractérisés par différents types de surfaces. Des études micrométéorologiques ont été menées en vue de quantifier et de comprendre les facteurs et les processus qui contrôlent les échanges de radiations, d'énergie, d'eau et de carbone entre la surface terrestre et l'atmosphère. Dans le cadre de cette session, organisée par la Société canadienne de météorologie agricole et forestière, des recherches jouant un rôle relatif aux mesures ou à la modélisation de l'interaction surface-atmosphère des écosystèmes canadiens seront présentées, et porteront, sans s'y limiter, sur les terres agricoles, les forêts, les marécages, les pâturages, la toundra arctique et subarctique.

Sécheresse, climat et société

Ronald Stewart, Richard Lawford - Université du Manitoba
John Pomeroy - Université de la Saskatchewan
Contact: ronald_stewart@umanitoba.ca

Les sécheresses sont des phénomènes courants du cycle de l'eau sur l'ensemble de la planète. Il s'agit de phénomènes récurrents des extrêmes météorologiques et climatiques, tout comme les inondations et les tornades, mais qui se distinguent en raison de leur longue durée et du fait qu'on ne peut déterminer leur commencement ni leur fin de façon précise. Les sécheresses sont relativement courantes au Canada, comme dans l'ensemble de l'Amérique du Nord, toutes les régions du continent étant touchées de temps à autre. Toutefois, elles sont le plus courantes et le plus marquées dans les régions centrales du continent; au Canada, les Prairies sont particulièrement vulnérables. L'augmentation potentielle de la fréquence des sécheresses est l'une des préoccupations les plus importantes en lien avec le changement climatique.

Cette séance vise à présenter des recherches du Canada et du monde entier sur les sécheresses. On traitera de la définition, de la caractérisation, des tendances et d'autres aspects des sécheresses, du rôle des sécheresses dans le système climatique, des prévisions de sécheresses à diverses échelles de temps, y compris celles qui sont associées au changement climatique, des répercussions des sécheresses et de l'état de préparation de la société aux sécheresses. On souhaite avoir des présentations de représentants du Réseau de recherche sur la sécheresse et d'autres chercheurs s'intéressant à ces phénomènes.

Interactions physiques et biologiques dans les environnements aquatiques

Tetjana Ross - Université Dalhousie
Contact: tetjana@dal.ca

La collaboration interdisciplinaire fut la clef du progrès en océanographie et en limnologie durant les 40 dernières années. Cette session encourage les contributions qui se nourrissent des interactions entre les disciplines comme l'océanographie physique/limnologie, qui furent représentées de bonne façon depuis longtemps aux congrès de la SCMO, et les disciplines de la biologie ou la biogéochimie. Les sujets traitant des études allant des échelles de dissipation jusqu'aux échelles de bassins ainsi que la recherche menée sur le terrain, en laboratoire ou par modèle numérique sont les bienvenus.

"Actuellement on ne peut pas concevoir une question océanographique sans avoir besoin de traverser les autres disciplines".- Thomas M. Powell (Océanographie, Septembre 2008)

Monitoring du temps et du climat au Canada – Activités en cours et orientation future

Mike Manore, Dave Wartman, Al Pietroniro, Jim Abraham - EC - Service météorologique du Canada
Contact: mike.manore@ec.gc.ca

Les observations sont au cœur de toute information météorologique et hydrologique, de toute recherche et de tout service. Mettre sur pied des réseaux de monitoring pertinents exige un travail considérable, et exploiter ces systèmes de manière durable présente des difficultés d'ordre scientifique, opérationnel et financier. Citons notamment l'obtention de données d'observation représentatives de l'environnement canadien, vaste, rude et souvent isolé, les exigences toujours croissantes des utilisateurs, et l'adaptation aux technologies qui ne cessent d'évoluer. Cette séance vise à explorer les pratiques actuelles et émergentes dans le domaine du monitoring du temps et du climat d'une part, et d'autre part, à stimuler la discussion sur l'avenir des réseaux d'observation au Canada. Nous proposons quatre sous-thèmes : réseaux opérationnels de monitoring, instrumentation et technologie, monitoring spatiale, orientations stratégiques du monitoring. Le dernier sous-thème inclura trois articles, suivit d'une discussion sur les orientations stratégiques à donner au monitoring atmosphérique, hydrométrique et climatique au Canada.

Réalisations de la FCSCA – La première décennie

Dawn Conway - Fondation canadienne pour les sciences du climat et de l'atmosphère
Gordon McBean - Départements de géographie et de sciences politiques, Université de l'Ouest de l'Ontario
Contact: aston@cfcas.org

La Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA) célèbre ses 10 ans d'excellence en recherche. Grâce à son soutien, elle a donné un nouveau souffle aux sciences de l'atmosphère, de l'océan et du climat au Canada, favorisé la création de partenariats et contribué à former la prochaine génération d'océanographes et de spécialistes du climat et de l'atmosphère. La FCSCA a contribué financièrement à plus de 184 réseaux et projets – investissant plus de 117 millions de dollars dans la recherche universitaire. Grâce à la collaboration avec des scientifiques d'autres secteurs, les résultats des travaux de recherche ont été repris et utilisés, au bénéfice de tous les Canadiens. Cette séance soulignera les réalisations de la FCSCA, son influence sur la communauté scientifique et les répercussions des travaux qu'elle a financés sur les activités, l'élaboration de politiques et le bien-être des Canadiens.

ARCTIQUE

L'environnement arctique au 21e siècle

James Drummond - Université Dalhousie
Contact: james.drummond@dal.ca

L'environnement arctique connaîtra des changements considérables au cours du 21e siècle. L'atmosphère, l'océan, la terre et les écosystèmes subiront un grand stress. Nous aurons de plus en plus besoin de mesures et de modèles de l'environnement arctique pour comprendre la région et prendre des décisions concernant son avenir. Cette séance réunira des scientifiques de divers horizons de la SCMO et de l'UGC qui parleront de leur expérience et de l'état actuel de l'Arctique et de ce qui l'attend.

Cryosphère : rétroaction cryosphère-climat

Paul Kushner - Département de physique, Université de Toronto
Richard Fernandes - Secteur Sciences de la Terre, Ressources naturelles Canada
Contact: paul.kushner@utoronto.ca

La rétroaction cryosphère-climat comprend des processus cryosphériques qui amplifient ou atténuent la réaction au forçage radiatif que causent les variations de la composition atmosphérique et le rayonnement solaire incident. Une telle rétroaction influe sur la sensibilité du climat à l'échelle régionale et mondiale, de même que sur la réaction cryosphérique directe (couche de neige et étendue de la glace de mer, fonte et accumulation de la neige et de la glace de mer, dynamique du pergélisol) à ce forçage. Nous sollicitons des communications qui mettent en lumière les dernières découvertes qui aident à comprendre les processus et les forces en jeu dans la rétroaction cryosphère-climat. Il peut s'agir de travaux d'observation, de modélisation ou théoriques qui s'appliquent aux climats passés, récents ou projetés.

Programme Storm Studies in the Arctic (STAR)

John Hanesiak - Centre des sciences d'observation de la Terre, Université du Manitoba
Ronald Stewart
Contact: fisico@cc.umanitoba.ca, ronald.e.stewart@gmail.com

Compte tenu du développement de l'industrie dans le Nord et de la rapidité du changement climatique dans cette région, il est de plus en plus important d'avoir une bonne compréhension des événements météorologiques extrêmes dans l'Arctique, qui auront une incidence importante sur les régimes météorologiques à des latitudes élevées. Le programme Storm Studies in the Arctic (STAR) est un réseau de recherche de quatre ans (2007-2010) portant sur les événements météorologiques extrêmes et leurs dangers pour le sud-est de l'Arctique auquel participent des chercheurs de plusieurs universités et d'Environnement Canada.

Dans le cadre de ce réseau, on a mené une campagne météorologique majeure sur le terrain du 10 octobre au 30 novembre 2007 et en février 2008, laquelle était axée sur le sud de l'île de Baffin, une région caractérisée par des tempêtes d'automne et d'hiver intenses. Les données recueillies visaient à documenter et à mieux comprendre les systèmes météorologiques dans l'Arctique et à améliorer les prévisions, notamment dans le cas des événements météorologiques extrêmes comme les vents violents, les précipitations abondantes et la poudrerie. On s'est également penché sur les effets du terrain, de l'air et de la mer sur les processus de temps violent, qui sont d'une grande importance pour la région de l'île de Baffin. La participation de la collectivité locale aux communications bidirectionnelles constitue également un élément important du réseau STAR.

Pour cette séance, on souhaite avoir non seulement des présentations du réseau STAR, mais également des travaux portant sur tous les aspects de l'analyse et de l'amélioration des prévisions des conditions météorologiques à des latitudes élevées, des études sur le temps violent à des latitudes élevées, des observations des conditions météorologiques et des études de modélisation. On cherche également des présentations sur le partage de connaissances avec les collectivités locales.

Stabilité du climat polaire

Guido Vettoretti - Université de Toronto
Shawn Marshall - Université de Calgary
Markus Kienast - Université Dalhousie
Contact: g.vettoretti@utoronto.ca

L'amplification du changement climatique à des latitudes élevées due au forçage des gaz à effet de serre risque d'influer grandement sur la stabilité de la cryosphère polaire. La stabilité du climat polaire se rapporte à diverses échelles de temps, des échelles météorologiques aux échelles géologiques, et a été influencée par le forçage naturel et anthropique du climat. Les présentations données au cours de cette séance comprendront, entre autres, des recherches menées dans le cadre du réseau de la stabilité du climat polaire (Polar Climate Stability Network – PCSN). Ce que l'on sait du système climatique provient en grande partie des recherches en paléoclimatologie et en paléocéanographie se rapportant au Quaternaire. Cette séance vise les chercheurs qui s'intéressent à la dynamique des océans et du climat des périodes antérieures; on invite à donner des présentations sur les climats chauds et froids des époques géologiques récentes et du temps profond. On souhaite également avoir des présentations sur la stabilité du climat polaire aujourd'hui, de même que sur l'état actuel du climat polaire et de la cryosphère. On cherche aussi des contributions provenant de l'analyse de données géophysiques (marines et terrestres) et de la modélisation des états passé, actuel et futur des glaciers continentaux, afin de traiter des sujets suivants :

- amplification polaire du changement climatique;
- utilisation des isotopes de l'oxygène comme traceurs des processus climatiques;
- bilan massique de la cryosphère polaire; téléconnexions hautes latitudes/basses latitudes;
- réaction de la circulation thermohaline de l'Atlantique;
- étude des époques antérieures comme analogues pour l'avenir;
- dynamique des périodes à faible effet de serre et à effet de serre important.

Analyse opérationnelle et prévision des glaces de mer

Mark Buehner, - Division de la recherche météorologique, Environnement Canada
Tom Carrieres, Roger de Abreu, - Service canadien des glaces, Environnement Canada
Greg Flato, - Division de la recherche climatique, Environnement Canada
Contact: Mark.Buehner@ec.gc.ca

Le changement climatique dans l'Arctique, prouvé par la réduction inégalée de l'étendue des glaces observée au cours des dernières années, entraîne une hausse du transport maritime et de l'exploitation des ressources naturelles dans les eaux couvertes de glace et dans leur voisinage. L'utilisation judicieuse des analyses et des prévisions précises et opportunes, comme les produits opérationnels du Service canadien des glaces (SCG), peut procurer de grands avantages pour ces activités, tant sur le plan de l'économie que de la sécurité. Des données précises sur la glace de mer peuvent aussi améliorer la prévision météorologique numérique dans les régions nordiques, surtout si on utilise des modèles couplés glace-océan-atmosphère.
Dernièrement, au SCG et à la Division de la recherche météorologique, on a étudié l'utilisation d'une méthode objective d'analyse et de prévision pour réaliser des prévisions tactiques, semblable à celle qu'on utilise pour la prévision météorologique numérique. Cette méthode repose sur des techniques d'assimilation de données et combine l'information provenant des données d'observation (principalement d'instruments satellitaires) et de modèles numériques. Pour les prévisions à longue portée, des techniques de prévision d'ensemble et de modélisation statistique sont à l'étude dans le cadre de projets comme le Projet canadien de prévision des glaces à long terme. Cette séance portera sur les éléments requis pour pouvoir mettre au point de telles méthodes objectives, soit les observations (tous les aspects de l'utilité de l'information fournie par les données de télédétection et les données in situ pour connaître la concentration, l'épaisseur ou le type de glace de mer, que ce soit par assimilation directe ou au moyen d'un

algorithme d'extraction); les modèles prévisionnels (tous les aspects de la mise au point des modèles des glaces de mer numériques et statistiques et leur application à la prévision de la glace de mer sur des échelles de temps allant de quelques jours à des saisons complètes, voire des périodes plus longues); l'assimilation de données – tous les aspects de la mise au point et de l'application de techniques d'assimilation des données d'observation de la glace de mer afin de produire des estimations objectives des conditions de glace de mer et fournir des conditions initiales sur lesquelles fonder les modèles prévisionnels.

AIP et les études reliées à l'atmosphère, l'océanographie et l'hydrologie

Will Perrie - Pêches et océans Canada
Contact: perriew@dfo-mpo.gc.ca

L'Année Internationale Polaire (AIP) 2007-2008 etait un programme de deux ans de science, recherche et éducation centré sur les régions polaires. Les chercheurs canadiens et internationaux des universités, des communautés nordiques et les gouvernements travaillent pour avancer notre compréhension des dimensions sociales, économiques et santés aussi bien que les processus géophysiques, climatiques et biologiques. Les soumissions sont bienvenues parmi les projets de AIP ainsi que d'autres sources qui contribueront à notre compréhension des processus atmosphériques, océanographique et hydrologique dans l'Arctique.

Modélisation de système pour une meilleure politique arctique

Evan Davies - Université de l'Alberta
Jennifer Lukovich - Université du Manitoba
Contact: lukovich@cc.umanitoba.ca

La dynamique des systèmes et les techniques de modélisation de système fournissent des outils permettant d'associer la science à l'élaboration de politiques concernant l'Arctique canadien. La dynamique des systèmes, qui représente une stratégie multidisciplinaire, offre un aperçu des causes complexes des événements du monde réel en établissant la façon dont la rétroaction non linéaire dans un système entraîne des comportements complexes et souvent contre-intuitifs. Elle permet de relever les politiques importantes et de mieux comprendre la structure des systèmes et leurs interconnexions, en plus de fournir un aperçu des interactions complexes entre les sujets de multiples disciplines.

Les problèmes que posent le changement climatique et la mondialisation offrent la chance aux collectivités du nord de devenir des modèles en ce qui concerne la durabilité et l'autonomie. Cette séance portera sur l'avenir de l'Arctique canadien et de ses habitants en s'appuyant sur une stratégie de modélisation de système qui représente de façon explicite les rétroactions entre les conditions physiques (p. ex., étendue de la glace marine, érosion des côtes, fonte du pergélisol, température de l'air en surface, vents) et socioéconomiques (disponibilité des ressources naturelles et de l'énergie renouvelable, population, consommation d'énergie, transports, infrastructure) changeantes. Les conclusions des travaux devraient aider dans l'élaboration de politiques favorisant la durabilité et l'autonomie chez les collectivités du nord.

On souhaite avoir des travaux portant sur les connexions entre, d'une part, les collectivités du nord et, d'autre part, le développement des technologies en ce qui concerne l'énergie renouvelable et de remplacement, la science du changement climatique, la gestion des ressources en eau, l'infrastructure dans le nord, le savoir traditionnel et le rôle de la continuité culturelle, en cherchant à établir des politiques bénéfiques qui respectent la tradition des collectivités du nord et à relever les options d'élaboration de politiques dans un cadre de gouvernance changeant. On souhaite obtenir des présentations d'ingénieurs, de chercheurs dans les domaines des sciences sociales et des sciences naturelles, de membres/représentants de collectivités du nord et de décideurs.

HYDROLOGIE

Séance générale sur l'hydrologie

Sean Carey - Université Carleton
Contact: sean_carey@carleton.ca

Cette séance portera sur les contributions à l'hydrologie qui ne seront pas présentées au cours de séances spécialisées. Elle portera plus particulièrement sur les contributions liées aux méthodes géophysiques et à la télédétection, aux prévisions des écoulements fluviaux et aux variations de l'eau souterraine et de l'humidité du sol.

Hydrologie forestière et gestion de l'eau

Paul Egginton
Contact: paul.egginton@nrcan-rncan.gc.ca

Cette séance portera sur les contributions à l'hydrologie forestière et la gestion de l'eau.

Incertitude quant aux effets du changement climatique sur le cycle de l'eau

Katrina Bennett, David Rodenhuis1 - Pacific Climate Impacts Consortium

Biljana Music, Daniel Caya - Ouranos, consortium sur les changements climatiques
Contact: kbennett@uvic.ca

Il sera important, pour la gestion des ressources en eau, de tenir compte de l'incertitude entourant les effets du changement climatique sur les régimes hydrologiques régionaux. Bien que l'on ait réalisé des progrès importants en ce qui concerne l'élaboration de modèles climatiques mondiaux, les techniques de mise à l'échelle inférieure et la modélisation hydrologique, rares sont les méthodes et outils permettant de faire une évaluation quantitative de l'incertitude et pouvant être appliquées facilement par les décideurs. Comment les gestionnaires peuvent-ils prendre des décisions appropriées malgré cette incertitude, et comment la communauté scientifique peut-elle réagir en leur fournissant des solutions applicables pour la planification? Cette séance vise à présenter un échantillon représentatif de diverses techniques d'évaluation de l'incertitude entourant les effets du changement climatique sur le cycle de l'eau. On se penchera surtout sur les stratégies de quantification de l'incertitude appliquées par des gestionnaires de ressources en eau, des décideurs et des planificateurs, ainsi que sur les résultats de ces stratégies.

Amélioration de la compréhension des processus hydrologiques, de la paramétrisation et des prévisions dans les régions froides

John Pomeroy - Centre d'hydrologie, Université de la Saskatchewan
Sean Carey - Département de géographie et des études environnementales, Université Carleton
Alain Pietroniro - Relevés hydrologiques du Canada, Environnement Canada
Bill Quinton - Centre de recherche sur les régions froides, Université Wilfrid Laurier
Diana Verseghy - Service météorologique du Canada, Environnement Canada
Contact: ip3.network@usask.ca

Parmi les processus hydrologiques dans les régions froides, mentionnons l'accumulation, la redistribution, l'ablation et la fonte de la neige, le gel et le dégel du sol, l'écoulement d'eau sous la surface dans les sols partiellement gelés et les processus liés à la glace, comme l'évaporation, la fonte, le ruissellement et la redistribution de l'eau. Les progrès réalisés dans la représentation numérique de la neige et de la glace, de l'eau libre, des terrains organiques humides et du pergélisol des modèles hydrologiques et de la surface terrestre devraient améliorer les prévisions hydrologiques, météorologiques et climatiques dans les régions froides. Puisqu'ils dominent dans l'eau d'amont générant du ruissellement, les processus des régions froides ont des effets considérables sur les ressources continentales en eau, de même que sur le climat régional et mondial. Cette séance vise à améliorer la compréhension des processus, la paramétrisation et les prévisions dans les bassins rarement jaugés des régions froides du Canada, de même que d'autres régions alpines et polaires. À cette fin, on se penchera sur des sujets variés se rapportant à l'écoulement et au stockage de l'eau dans les régions ou les saisons froides. On aimerait beaucoup avoir des études détaillées des processus, de même que des études novatrices de modélisation.

Classification, modélisation et études comparatives des mécanismes de contrôle environnementaux sur la réaction hydrologique des bassins versants

April James - Université d'État de la Caroline du Nord
Ilja Tromp-van Meerveld - Université Simon-Fraser
Contact: april_james@ncsu.edu

La comparaison de la réponse hydrologique des bassins versants est difficile étant donné les fluctuations des conditions environnementales (p. ex. conditions d'humidité antérieures, caractéristiques des tempêtes), les mécanismes de contrôle environnementaux (p. ex. climat, topographie, sols, géologie) et limites des données disponibles. Malgré ces difficultés, les comparaisons se sont révélées utiles. Plusieurs études portant sur les pentes et les petits bassins versants, par exemple, ont permis de déceler un comportement seuil dans la réponse hydrologique aux caractéristiques des tempêtes et aux conditions d'humidité antérieures, et de déterminer les facteurs environnementaux fondamentaux qui régissent la production de ruissellement, comme la topographie de surface, la topographie de subsurface et la profondeur du sol, le type de couverture du sol et sa répartition. En plus des études comparatives, on observe une augmentation récente du nombre d'études de modélisation ou d'expériences virtuelles visant à déterminer les mécanismes qui influent sur le ruissellement. Malgré ces progrès, beaucoup d'interrogations demeurent sans réponse à l'égard de facteurs environnementaux précis : où sont-ils le plus important? Dans quelles conditions? À quelle échelle?

Dernièrement, une série de travaux tentait de s'attaquer aux difficultés que représentent les études comparatives en fournissant des cadres organisationnels servant à classer les bassins versants et leur comportement. Compte tenu de l'importance accordée récemment à la classification des bassins versants, il est nécessaire de soumettre ces cadres à des essais méthodologiques avec des ensembles de données et des modèles nouveaux et existants afin de déterminer les mécanismes de contrôle environnementaux essentiels et de généraliser leur importance.

Pour cette séance, nous acceptons toutes les études portant sur la classification des bassins versants, les comparaisons entre bassins versants et la modélisation des bassins versants qui visent à déterminer les mécanismes de contrôle environnementaux parmi les plus importants pour la production de ruissellement.

Glaciers de l'ouest de l'Amérique du Nord : passé, présent et futur

Brian Menounos - Université du Nord de la Colombie Britannique
Dan Moore, Garry Clarke - Université de la Colombie-Britannique
Contact: menounos@unbc.ca

Les glaciers de montagne sont des ressources importantes en eau; toutefois, ils demeurent un élément mal connu du réseau hydrologique. Leurs dimensions peuvent changer selon la température et les précipitations, c'est pourquoi les fluctuations passées révèlent souvent la durée et l'ampleur des épisodes climatiques. Dans l'Ouest canadien, le ruissellement glaciaire constitue une composante essentielle de l'écoulement de surface jusqu'aux bassins versants des Rocheuses de l'est, où l'on a recours aux eaux de ruissellement pour l'agriculture, la consommation urbaine et l'industrie. La production d'énergie hydroélectrique repose également sur le ruissellement glaciaire dans les bassins englacés de la Colombie-Britannique. De plus, la diminution de l'étendue des glaciers dans l'Ouest canadien et en Alaska contribue fortement à l'élévation du niveau de la mer. Pour la séance proposée, on souhaite avoir des présentations sur des recherches qui permettent de définir l'ancienne étendue des glaciers, qui portent sur la relation entre le climat/la météorologie et l'alimentation des glaciers, qui concernent le bilan massique ou l'hydrologie des glaciers et qui comprennent une modélisation du passé ou du futur des glaciers. On cherche surtout des présentations qui rendent compte des répercussions de la réduction de l'étendue des glaciers et qui s'appuient sur une stratégie multidisciplinaire pour étudier les changements des glaciers de la Cordillère nord-américaine.

GÉODÉSIE

Géodésie et géodynamique

Joseph Henton - Division des levés géodésiques, Ressources naturelles Canada
Marcelo Santos - Département de géodésie et d'ingénierie géomatique, Université du Nouveau-Brunswick
Contact: jhenton@nrcan.gc.ca

Cette séance est ouverte aux communications portant sur le vaste domaine des sciences géodésiques et de ses applications à la géodynamique. Nous invitons les personnes intéressées à soumettre des projets de communication traitant d'applications de pointe en mesures géodésiques utilisant des techniques terrestres ou spatiales individuelles (p. ex. GNSS, ITGB, gravité) ou combinées (SMOG), et de l'interprétation du signal géodésique et de son application aux recherches sur la rotation de la Terre et sur le mouvement chandlérien, à la détermination précise de l'orbite, à l'analyse et à la prévision des processus faisant intervenir les océans, l'atmosphère et les processus internes de la Terre.

Calcul informatisé avancé en géomatique et collaboration Web

Rod Blais, Mohamed Elhabiby - Université de Calgary
Contact: blais@ucalgary.ca, mmelhabi@ucalgary.ca

La géomatique et, de manière plus générale, les sciences de la Terre sont de plus en plus axées sur les systèmes et font intervenir la recherche multidisciplinaire liée aux sciences de la Terre. Parmi les défis qui se posent au chapitre du calcul informatisé, citons l'augmentation exponentielle du volume des données, la diversité et la complexité des ensembles de données, le stockage des données, l'accès aux données et leur conservation, l'analyse multirésolution et la synthèse, l'intégration des données sémantiques et syntaxiques, la visualisation avancée, les calculs distribués et la collaboration Web. Nous invitons les personnes intéressées à soumettre des projets de communication orale ou par affiches sur l'un ou l'autre de ces sujets.

Référentiel altimétrique nord-américain fondé sur le géoïde
Marc Veronneau - Ressources naturelles Canada
Dan Roman - US National Geodetic Survey
Contact: marcv@nrcan.gc.ca

L'Amérique du Nord est en voie d'adopter un référentiel altimétrique fondé sur le géoïde. La mise en œuvre d'un tel référentiel altimétrique pourrait se faire dès 2013 au Canada, et un peu plus tard au cours de la même décennie aux États-Unis. Les référentiels altimétriques ont toujours été accessibles au moyen de marqueurs passifs, dont l'entretien coûte cher et demande beaucoup de temps puisqu'il nécessite une équipe de mise à niveau qui traverse littéralement le pays à pied. En outre, ces marqueurs sont principalement situés le long de routes importantes et de chemins de fer et se limitent par conséquent à la partie sud du Canada. Aujourd'hui, les systèmes mondiaux de navigation par satellite (p. ex. GPS) et les missions gravimétriques satellites actuelles (GRACE et GOCE) procurent l'infrastructure spatiale adéquate pour déterminer avec exactitude et efficacité la hauteur et le géoïde, respectivement. Nous pourrons ainsi obtenir des hauteurs au-dessus du niveau moyen de la mer qui sont communes et constantes partout en Amérique du Nord (terre, lacs et océans), ce qui permettra de gérer efficacement les eaux, notamment. En outre, cela procurera un lien entre les données terrestres et océanographiques.

La séance portera sur des sujets liés à la définition, la réalisation et l'entretien du référentiel altimétrique nord-américain. Les sujets d'intérêt comprennent la collecte et la validation des données, l'amélioration de la théorie de la modélisation du géoïde, les procédures de surveillance des changements dans le géoïde et les référentiels océanographiques.

BIOGÈOSCIENCE

Séance générale sur la biogéoscience
Altaf Arain, - Université McMaster
Elyn Humphreys - Université Carleton
Contact: arainm@mcmaster.ca

Cette séance comprendra des communications sur la biogéoscience qui ne conviennent pas bien aux autres séances spécialisées.

Interactions entre les cycles biogéochimiques
Carl Mitchell - Université de Toronto - Scarborough
Rick Bourbonniere - Environnent Canada
Merrin Macrae - Université de Waterloo
Contact: carl.mitchell@utoronto.ca

Le Canada se doit à tout prix de comprendre la myriade de processus qui régularisent les cycles biogéochimiques pour être mesure de réglementer correctement la lutte contre les émissions polluantes et de prendre des décisions judicieuses en matière de gestion de l'utilisation des terres. La complexité des processus hydrologiques et biogéochimiques et de leurs interactions rend difficile la formulation de solutions définitives. Les interactions et les rétroactions entre les différents cycles biogéochimiques, particulièrement aux interfaces des écosystèmes, ne font qu'accroître la difficulté. Cela est particulièrement vrai lorsque les mesures destinées à atténuer les effets délétères d'un processus entraînent la production ou l'accumulation d'une autre substance nocive. Les communications présentées dans le cadre de cette séance devraient surtout porter sur l'interaction des différents cycles biogéochimiques qui surviennent à l'échelle tant microscopique que macroscopique. Nous sommes à la recherche de projets de communication présentant les vastes perspectives de disciplines comme les biogéosciences, l'hydrologie, l'écologie et la géologie. Seront également pris en considération les projets de communication portant sur des données initiales de terrain, de laboratoire ou de modélisation. Citons à titre d'exemples l'interaction entre les cycles du soufre et du carbone, comme la suppression de la méthanogénèse par stimulation de la sulfatoréduction, ou le cycle et le transport des nutriments agricoles et leur impact sur la biogéochimie riveraine et fluviale. Quoi qu'il en soit, nous invitons les personnes intéressées à soumettre des projets de communication sur divers cycles biogéochimiques en interaction ou sur des cycles observés aux interfaces. Comme le laisse entendre le titre de la séance, nous sommes particulièrement intéressés par les communications portant sur les études biogéoscientifiques prospectives et sur des façons d'intégrer les résultats aux politiques.

Cycle du carbone des forêts et tourbières canadiennes

Hank Margolis - Université Laval
Harry McCaughey - Université Queen's
Contact: Hank.Margolis@sbf.ulaval.ca

Dans cette séance, on présentera quelques-uns des impacts et des résultats du réseau de recherche Fluxnet-Canada (RRFC) et du Programme canadien du carbone (PCC), qui réunissent des chercheurs d'universités et d'organismes provinciaux et fédéraux afin d'étudier le rôle des forêts et des tourbières dans le cycle du carbone au Canada et d'intégrer ces résultats à des initiatives de recherche à l'échelle du continent et de la planète. Plus de 100 étudiants des cycles supérieurs et du postdoctorat ont été formés. Le RRFC a duré de 2002 à 2007; il s'agissait du premier réseau national mesurant de façon systématique et continue les flux de carbone, d'eau et d'énergie des forêts et des terres humides aménagées du Canada. Les flux de dioxyde de carbone, de chaleur, d'eau et de quantité de mouvement ont été mesurés selon la méthode de covariance des turbulences au sommet des tours de sites sélectionnés dans l'ensemble du pays, de la Colombie-Britannique au Nouveau-Brunswick. On a aussi recueilli un ensemble de données météorologiques de base et de données écologiques propres au site. On s'est servi de ces données pour élaborer et mettre à l'essai des modèles de bilan du carbone de l'écosystème à l'échelle du site et de la région. Le PCC (2007-2010) a misé sur le travail mené dans le cadre du RRFC et a élargi le programme afin d'inclure des mesures de « tours élevées » et une modélisation d'inversion atmosphérique du bilan du carbone régional. On présentera les effets de plusieurs types de perturbations des forêts, y compris le changement des taux de séquestration de carbone à la suite d'activités d'exploitation forestière et d'incendies, de même que des données sur ces changements en chronoséquences pour le pin gris

(Saskatchewan), l'épinette noire (Québec), le pin blanc (Ontario) et le douglas de Menzies (Colombie-Britannique). On traitera aussi de l'importance de ce travail pour l'établissement des politiques publiques.

SOLIDE TERRESTRE

De la croûte au noyau : observations de la structure et modèles

Catrina Alexandrakis - Université de Calgary
Jeff Gu - Université de l'Alberta
Contact: alexanc@ucalgary.ca

La disponibilité d'instruments à large bande a considérablement augmenté notre capacité à recueillir des données sur les structures sismiques et à les caractériser. Elle favorise les percées théoriques et facilite la mise au point d'applications originales relatives au manteau et au noyau terrestres. Cette séance vise à mettre en lumière les derniers résultats et les méthodologies les plus récentes qui tirent profit de la couverture améliorée des données mondiales et régionales pour en venir à une meilleure compréhension de la dynamique de la lithosphère, de la convection mantellique et des interactions noyau-manteau. Nous mettons l'accent sur les divers aspects du problème « global » et sur des solutions plus efficaces à ce problème. Les communications portant sur un large éventail de profondeurs, d'échelles spatiales et d'emplacements géographiques sont les bienvenues.

Processus et structure du manteau

Julian Lowman - Université de Toronto
Gary Jarvis - Université York
Contact: lowman@utsc.utoronto.ca

Les processus survenant à l'intérieur du manteau régissent la façon dont la chaleur s'échappe du manteau et du noyau d'une planète rocheuse comme la Terre. Ils englobent les forces responsables de la tectonique des plaques, soit le volcanisme, les séismes et l'orogenèse. Ils influent également sur la topographie et le champ gravitationnel des planètes et, dans le cas de la Terre, sur la « géodynamo » et la formation des ressources en minéraux et en hydrocarbures. Pour mieux comprendre la dynamique du manteau terrestre, il est important de mieux en connaître la structure minéralogique, chimique et thermique, surtout pour les régions comprises dans les couches limites thermiques. Pour cette séance, on souhaite avoir des présentations sur une gamme variée de sujets liés au manteau de la Terre et aux manteaux des planètes en général, notamment dans les domaines de la sismologie, de la physique des minéraux à haute pression, de la géodynamique et de la tectonophysique.

Applications pour radar à synthèse d'ouverture polarimétrique destinées à la géophysique du solide terrestre et de l'océan : (séance spéciale sur RADARSAT-2)

Wooil Moon - Université du Manitoba
Contact: wmoon@cc.umanitoba.ca

Avec le lancement récent de plusieurs systèmes SAR pleinement polarimétriques embarqués sur des satellites comme ALOS (Advanced Land Observation Satellite) (Agence d'exploration aérospatiale japonaise, Japon), TerraSAR-X (DLR, Allemagne), RADARSAT-2 (MDA/ASC, Canada), la création de nouvelles applications non seulement arrive à point nommé, mais est urgente pour la géophysique. Je propose d'organiser une séance spéciale qui mettra l'accent sur les applications SAR pleinement polarimétriques pour la géophysique. Dans la mesure du possible, j'inviterai quelques experts et chercheurs internationaux dans le domaine, en plus des scientifiques et ingénieurs canadiens qui présenteront des communications.

Microzonage sismique

Dariush Motazedian - Université Carleton
Jim Hunter - Commission géologique du Canada, Ottawa
Contact: Dariush_Motazedian@Carleton.ca

Le microzonage sismique vise à améliorer les estimations de l'aléa sismique par l'intégration d'éléments d'information détaillés sur la réaction d'un site de tremblement de terre à l'échelle d'une ville ou d'une région. Il s'agit d'un volet important de l'élaboration d'un modèle de prévision plus réaliste des mouvements du sol destiné aux analyses de l'aléa sismique, car l'intensité des secousses sismiques est fortement déterminée par les caractéristiques du site. Les effets de site sont paramétrés en fonction des propriétés géophysiques et géotechniques du sol. Citons à titre d'exemple le paramètre Vs-30 (vitesse moyenne des ondes de cisaillement jusqu'à une profondeur de 30 m), actuellement utilisé dans nombre de codes du bâtiment comme indice servant à mesurer les effets d'amplification du site. Ce paramètre fournit une mesure quantitative permettant de tenir compte uniquement de certains aspects du comportement des sols sismiques, alors que d'autres facteurs comme la profondeur du sol et les périodes fondamentales sont aussi très importantes. Il est possible d'améliorer les prévisions du mouvement du sol soit par des corrections « génériques » utilisant les facteurs d'amplification du site, ou par des analyses géotechniques approfondies des effets de site locaux. Nous invitons les personnes intéressées à soumettre des projets de communication portant sur tout aspect des études de microzonage sismique, et tout particulièrement sur celles susceptibles d'apporter des améliorations aux techniques actuellement utilisées pour la détermination des effets de site.

Exploration des profondeurs de la Terre : progrès en physique des minéraux et des roches réalisés grâce aux laboratoires

Hans J. Mueller - Centre de recherches géoscientifiques allemand GFZ
Rick Secco - Université de l'Ouest de l'Ontario
Contact: hjmuel@gfz-potsdam.de

On voit de plus en plus qu'il est nécessaire, pour réaliser des progrès dans les études géophysiques de l'intérieur de la Terre, d'avoir une compréhension fondamentale des processus physiques et chimiques qui y surviennent, de même qu'une connaissance exacte de la relation entre les propriétés des matières/structures et les propriétés physiques des roches et des minéraux dans des conditions in situ. Grâce à de nouvelles techniques de mesure numérique et à des matériaux améliorés, on a réalisé des progrès considérables au cours des dix dernières années. On a accéléré ces progrès grâce aux capacités croissantes des simulations numériques, qui permettent de traiter les structures et processus géologiques, peu importe leur complexité. Les modèles numériques réalistes requièrent des données in situ fiables et précises afin de répondre aux exigences pour l'interprétation des nouveautés en géophysique, en géodynamique et en géologie. Cette séance multidisciplinaire vise à stimuler les discussions entre les géophysiciens, les géologues, les spécialistes de la physique des minéraux et des roches et les spécialistes des modèles numériques. Nous invitons les chercheurs de toutes ces disciplines à présenter leurs résultats et leurs idées et à participer à cet échange d'information, dont ils bénéficieront certainement.

Nouveautés en géophysique aérienne

Claire Samson - Département des sciences de la Terre, Université Carleton
Luise Sander - Sander Geophysics Ltd.
Contact: claire_samson@carleton.ca

La géophysique aérienne est un domaine compétitif et innovateur qui évolue rapidement et qui s'adapte aux demandes du marché pour des produits à valeur ajoutée, surtout dans le climat économique actuel.

Dans cette séance, on présentera les nouveautés en ce qui concerne les appareils, les capteurs et les méthodes d'analyse pour les levés gravimétriques aériens, le magnétisme, l'électromagnétisme, la radiométrie et l'imagerie laser. On s'intéresse particulièrement aux nouveaux appareils pouvant révolutionner l'exploration des terrains accidentés, comme les systèmes héliportés à faible altitude et les avions sans pilote. La fusion de données recueillies par des capteurs géophysiques différents permet de créer des produits visuels et des cartes améliorés et constitue un domaine d'intérêt de plus en plus important. Le lidar aérien, par exemple, constitue maintenant une technologie fort utile qui permet de concevoir des modèles altimétriques numériques pouvant être combinés aux données classiques recueillies sur le terrain. Cette stratégie intégrée permet de détecter et de délimiter les cibles de façon plus efficace. Compte tenu du volume accru de données, on élabore de nouvelles stratégies d'analyse afin d'obtenir des résultats rapidement, de manière efficace et, dans bien des cas, en temps réel ou quasi réel.

Pour cette séance, on souhaite avoir des travaux portant sur les nouveautés technologiques et des cas concrets pour les applications allant de l'exploration des ressources naturelles à la cartographie des terrains inexplorés. On cherche surtout à obtenir, dans le cadre du thème général de la conférence, des travaux se rapportant à la surveillance environnementale. La séance vise également à réunir les géophysiciens et les ingénieurs qui participent à des recherches et à d'autres activités en géophysique aérienne et qui travaillent dans le milieu universitaire, le secteur public ou le secteur privé.

Géophysique dans les sites écologiquement vulnérables

Claire Samson - Département des sciences de la Terre, Université Carleton
Erwan Gloaguen - INRS, Centre Eau, Terre & Environnement, Quebec, QC
Contact: claire_samson@carleton.ca

En lien avec le thème général du congrès (notre terre, notre air, notre eau : notre avenir), cette séance porte sur les études géophysiques actuelles dans des sites écologiquement vulnérables. Cela englobe les milieux naturels délicats, comme les corridors de la faune et les terrains marécageux, où les levés géophysiques doivent être effectués de façon non destructive. Il peut aussi s'agir de sites problématiques, comme les bassins de retenue des résidus miniers et les lieux d'enfouissement, dont les effets sur l'environnement nécessitent une surveillance durant de longues périodes.

On souhaite avoir des présentations sur les progrès technologiques, les pratiques exemplaires et des cas concrets concernant une gamme variée d'applications pour l'ensemble du processus : sélection, conception, exploitation et déclassement du site. Cela englobe le recours à la géophysique de surface pour délimiter et suivre les panaches de contaminants; les diagraphies géophysiques de puits de surveillance, les levés géophysiques en appui à des évaluations environnementales de sites, les méthodes géophysiques d'évaluation de la stabilité des bassins de retenue et les méthodes de surveillance de l'eau d'exhaure acide. On souhaite avoir des exemples pour toutes les méthodes géophysiques – gravité, méthodes électriques et électromagnétiques, géoradar, radiométrie, etc.

La séance vise à réunir les géophysiciens et les représentants d'autres disciplines clés menant des activités de surveillance environnementale et de restauration de sites, comme les ingénieurs en environnement, civils et miniers et les spécialistes en hydrogéologie, en hydrologie et en biogéologie.

Risques sismiques

Kristy Tiampo, Robert Shcherbakov - Université de l'Ouest de l'Ontario
Contact: ktiampo@uwo.ca

Au cours des dernières années, les progrès réalisés en ce qui concerne les analyses théoriques, les expériences de laboratoire, les observations sur le terrain et les simulations par ordinateur ont permis de se rapprocher de l'objectif à long terme qui consiste à bien comprendre la nature des sources sismiques et à établir un modèle physique quantitatif pour l'ensemble du processus sismique. Toutefois, il reste un grand travail à accomplir afin de tirer profit de ces progrès pour améliorer les estimations des risques sismiques. Pour cette séance, on cherche des présentations qui aideront à comprendre le processus sismique sur le plan de la physique. On souhaite surtout avoir des études des méthodes systématiques émergentes qui accroissent les connaissances des processus physiques responsables de la distribution des séismes dans l'espace et le temps, de même que de nouveaux modèles, de nouvelles technologies et de nouveaux outils qui permettent de quantifier le processus sismotectonique et son évolution, ainsi que les estimations des risques sismiques associés pour diverses régions tectoniques. On mettra l'accent sur les processus de nucléation et de rupture dynamique associés aux séismes, sur la modélisation physique complète, sur les profils espace-temps de la sismicité et des domaines géophysiques connexes, ainsi que sur l'estimation des risques sismiques.

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