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

www.cmos.ca/congress2011

Race Rocks Lighthouse: Photo courtesy of SpringTideCharters

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Special thanks to Sophie Bonnet and Philippe Benoit for volunteer translation services for the program book.

Canadian Meteorological and Oceanographic Society (CMOS) presents:

Ocean, Atmosphere and the Changing Pacific

PROGRAM

Editor: Lisa Vitols

45th CMOS Congress
June 5 – 9, 2011
Victoria, B.C.
http://www.cmos.ca/congress2011

Interactive Conference Schedule:
https://www1.cmos.ca/abstracts/congress_schedule.asp
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ISBN: 978-0-9732812-9-3

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BRITISH
COLUMBIA

June 2011

A Message from the Premier

As Premier of the Province of British Columbia, I am pleased to welcome everyone to the 45th annual Canadian Meteorological and Oceanographic Society Congress in Victoria, our beautiful capital city.

I wish you all the best in your deliberations as you discuss ideas, concerns and new research with colleagues as well as with members of government, academia and the private sector.

I hope you will also have an opportunity to enjoy all that Victoria has to offer from tourism to recreational and social options. It is a first class city with stunning views and plenty of land and water side events for you to enjoy. The people here are proud and friendly, and they work hard to ensure your time with us is both pleasant and memorable.

Welcome to Victoria!

Sincerely,

Christy Clark
Premier

Province of British Columbia
Office of the Premier
www.gov.bc.ca

#740, 999 Canada Place
Vancouver BC
V6C 3E1

THE CITY OF VICTORIA — OFFICE OF THE MAYOR

Greetings from the Mayor of Victoria

On behalf of the City of Victoria, I am pleased to welcome you to the Canadian Meteorological and Oceanographic Society's 45th Annual Congress.

I am honoured that you have chosen Victoria as the site of your Congress this year.

I have no doubts that the next few days will be challenging and inspiring. The exchange of creative and innovative ideas is vital for advancing our collective knowledge of the atmospheric and oceanic sciences; knowledge that intimately shapes our understanding of the world and society.

Uniting this community every year is commendable and necessary. I wish you all the best in your deliberations.

I hope that while you are here you can take some time to explore our beautiful city – our thriving downtown, unique neighborhoods, and the stunning natural beauty all around us. Most importantly, I hope you have the opportunity to connect with the local citizens; it is the friendly and welcoming people which make Victoria so special.

Sincerely,

Dean Fortin
MAYOR

No. 1 Centennial Square Victoria British Columbia Canada V8W 1P6
Telephone (250) 361-0200 Fax (250) 361-0348 Email mayor@victoria.ca

Welcome from the President

On behalf of CMOS, it my distinct pleasure to welcome you to our 45th Annual Congress with the theme of the "Ocean, Atmosphere and the Changing Pacific".

This Congress is the pre-eminent Canadian forum for the exchange of ideas involving the government, academic and private sectors in meteorology and oceanography. We will explore the applications and impacts of these ideas on a regional, national and international basis. Our program features the latest scientific results with close to 500 meteorological and oceanographic papers, as presented in plenary sessions, parallel scientific sessions and as posters.

The Congress also provides us with an opportunity to recognize outstanding colleagues, to network with our peers from across Canada and internationally through many social events and to learn about the world-class products and services offered by exhibitors.

Public outreach is an important part of the Congress activities. The program includes two public lectures by internationally recognized scientists, an Educators' Day, and a series of workshops on a variety of interesting and relevant topics.

I would like to thank all of our sponsors for their support of the Congress. Also, I wish to thank the dozens of dedicated volunteers who made this event possible, in particular Nathan Gillett, chair of the Local Arrangements Committee and Bill Merryfield, chair of the Scientific Program Committee.

Sincerely yours,

David Fissel

David Fissel
President
Canadian Meteorological
and Oceanographic Society

Social Program

Sunday June 5
Icebreaker Reception
Sponsors:
Pelmorex
ECO Canada
(to mark the launch of the P. Met. Certification)
18:30 - 21:30
19:15 Welcoming ceremony
Le-La-La First Nations dance troupe
Royal BC Museum
First Peoples Gallery
Level 2, Royal BC Museum
675 Belleville Street.
Walk out of the Victoria Conference Centre (VCC) main exit, turn right along Douglas, then turn right on Belleville.
Hors d'oeuvres and drinks will be served.
Tickets in your Registration package.


Royal BC Museum

Monday June 6
Student Pub Night
19:30
Meet in Victoria Conference Centre (VCC) lobby.


Historic Crystal Garden, c1925

Tuesday June 7
Parsons Luncheon
12:00 - 14:00
Crystal Garden
(across street from VCC main door)
720 Douglas Street

Wednesday June 8
CMOS Awards Banquet
18:00 – 19:00 Reception
Gallery in the Crystal Garden
Sponsor: Taylor & Francis, publisher of Atmosphere-Ocean
Free beverage and cash bar.
19:00 - 21:30 Banquet and Awards
Crystal Garden


Crystal Garden, c2010

Welcome from the Organizing Committees

On behalf of the Local Arrangements and Scientific Program Committees, it gives us great pleasure to welcome you to Victoria for the 45th Congress of the Canadian Meteorological and Oceanographic Society.

This year's scientific program features an array of high-profile plenary speakers, and a broad range of topical and exciting scientific sessions. We are giving special prominence to poster presentations this year, with two new poster prizes, and posters on display throughout the Congress in the spacious Carson Hall. The Congress theme, "Ocean, Atmosphere and the Changing Pacific", will highlight the wide-ranging impacts of changes in the vast ocean off Canada's western shore. Social highlights of this year's Congress include an icebreaker reception in the First Peoples Gallery of the Royal BC Museum, and a four-course banquet at the Crystal Garden, preceded by a hosted reception sponsored by publishers Taylor and Francis.

This year's meeting is quite a contrast from the last CMOS Congress held in Victoria in 2000, when the program consisted of slightly over 200 abstracts, the venue was a series of classrooms at the University of Victoria, and most of the talks were presented with the aid of an overhead projector. This year's program, with approximately 500 presentations, hosted in the excellent facilities of the Victoria Conference Centre, reflects the growth of CMOS in numbers and breadth, while technological advances continue to transform the way we conduct and present our research.

We wish to thank all who have dedicated their time and efforts toward making this Congress possible, especially the members of the Local Arrangements and Scientific Program Committees and the many volunteers who will be assisting with all aspects of the meeting.

We hope that in addition to taking part in the scientific and social activities at this year's Congress you will have time to enjoy exploring Victoria and its beautiful surroundings.

Yours sincerely,

Nathan J. Gillett

Nathan Gillett
Chair, Local Arrangements Committee

William J. Merryfield

Bill Merryfield
Chair, Scientific Program Committee

Organizing Committees

Local Arrangements Committee

Nathan Gillett	Local Arrangements Committee Chair
Bill Merryfield	Scientific Program Committee Chair
Greg Flato	Sponsorship
Daniel Roy	Facilities, Entertainment, Audio-Visual
Lisa Vitols	Educators' Day, Program Book
Knut von Salzen	Social Program
Kirsten Zickfeld	Communications
Angelica Peña	Webmaster
Frank Whitney	Exhibits
Michael Eby	Local Registration
Nilgün Kulan	Volunteers
Krista Zala	Educators' Day, Media
John Scinocca	Treasurer
Oscar Koren	Exhibits
Ian Rutherford	CMOS Executive

Scientific Program Committee

Bill Merryfield (Chair)	Environment Canada
Vivek Arora	Environment Canada
Phil Austin	University of British Columbia
Alex Cannon	Environment Canada
Stephen Dery	University of Northern British Columbia
Mike Foreman	Fisheries and Oceans Canada
Debby Ianson	Fisheries and Oceans Canada
Tara Ivanochko	University of British Columbia
Norm McFarlane	Environment Canada
Adam Monahan	University of Victoria
Francis Poulin	University of Waterloo

General Information

Congress Locations: Victoria Conference Centre (VCC) • Crystal Garden • Royal BC Museum

Registration and information desk

The registration and information desk in the Victoria Conference Centre will be staffed daily:

Sunday, June 5	14:00–19:00
Monday, June 6	7:30–16:00
Tuesday, June 7	8:00–16:00
Wednesday, June 8	8:00–16:00
Thursday, June 9	8:00–12:00

Message board

A message board will be available at Registration for your convenience to leave and receive messages from other attendees.

Tourist Information

Tourist information can be found at the Tourism Victoria Visitor Info Centre, across from the Fairmont Empress at the corner of the Inner Harbour. See also www.tourismvictoria.com or www.victoria.ca. For general travel on Vancouver Island please see www.travergence.com, or http://www.hellobc.com/en-CA/RegionsCities/VancouverIsland.htm

Local Arrangements Committee

Committee members can be identified by their blue nametags.

Daily Weather Briefings

The Weather Network will provide weather briefings each day at 8:20am, prior to the plenary.

Speaker Preparation Room

To ensure presentations run smoothly and on time, we have booked a Speaker Preparation Room in the Sooke Room at the VCC. Instructions on equipment, format, guidelines and uploading are available in this book (p.14) and online. The room, with a computer, will be open Monday to Thursday the same hours as the Internet Café.

Internet café

We are pleased to provide an internet café in the Saanich 2 Room at the VCC. There are 6 internet-ready computers but no access to printers or other peripherals. Hours of operation are:

Monday, June 6	7:30–18:00
Tuesday, June 7	8:00–18:00
Wednesday, June 8	8:00–18:00
Thursday, June 9	8:00–13:00

Free wireless internet is provided throughout the Congress area, passcode CMOS2011.

Conference Greening

Our efforts to reduce the ecological footprint of this conference include the following measures:

- Reusable lanyard and badge holders – please drop off at Registration before you leave
- Program books printed according to language preference made at registration
- No conference bag produced, extra material (tourism brochures, maps, etc.) available on request
- All venues and hotels are in easy walking distance
- Carbon offsets encouraged for travel to and from the Congress

A Word About the Society

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.

Victoria Volunteers

We are grateful for the help received from the congress volunteers. Volunteers can be identified by their blue CMOS Volunteer vests.

Germaine Gatien	Anne McCarthy	Sara Fissel
Stephen Sobie	Rick Lee	Sophie Bonnet
Yiran Peng	Rheannon Brooks	Ben Moore-Maley
Philippe Benoit	Janine Reitsma	Warren Lee
Ed Wiebe	Adam Bard	Shiliang Shan
Neil Swart	Ross Benton	Christina Schallenberg
Fouad Majaess	Dawn Sadowy	Alex Slonimer
Ines Ng Kam Chan	Norm Dressler	Murray Leslie
Cindy Wright	Evgeniya Petrova	Maria-Rosa McFarlane
Steve Romaine	Nicola Milutinovic	Ben Garrett
	Annie Bourbonnais	

Student Bursaries

Student travel bursaries are awarded to help facilitate student participation in the Congress. Awards are made by the Scientific Program Committee primarily on the basis of the abstract submitted, although amounts awarded may reflect the applicant's geographical location.

Student Bursary Recipients

Student		University
Thomas	Anderson	McGill University
Joël	Bédard	Université du Québec à Montréal
Thomas	Bergeron	Université du Québec
Sophie	Bonnet	Université du Québec à Montréal
Dominique	Bourdin	University of British Columbia
Daniel	Brown	University of Alberta
Baozhang	Chen	University of British Columbia
Christophe	Corbel	University of British Columbia
Matthew	Corkum	York University
Nikolay	Damyanov	McGill University
Michael	Dunphy	University of Waterloo
Livia	Dutra	University of São Paulo
Carmen	Emmel	University of British Columbia
Andre R	Erler	University of Toronto
Camille	Garnaud	Université du Québec à Montréal
Simon	Higginson	Dalhousie University
Xianmin	Hu	University of Alberta
Jerry	Jien	University of Toronto
Gavin	King	Dalhousie University
Manoj K	Kizhakkeniyil	University of Northern British Columbia
Karl Bryan	Lagman	Dalhousie University
Kinson	Leung	University of Toronto
Alireza	Mashayekhi	University of Toronto
Paul	Mattern	Dalhousie University
Thomas	Nipen	University of British Columbia
Christopher	Perro	Dalhousie University
Philippe	Pham	École de technologie supérieure
Andrew	Pinsonneault	Concordia University
Wolf	Read	University of British Columbia
Shiliang	Shan	Dalhousie University
Karen	Smith	University of Toronto
Nancy	Soontiens	University of Waterloo
Colin	Thackray	Dalhousie University
Ismael	Touani	École de technologie supérieure
Siraj	ul Islam	University of Northern British Columbia
Jennifer K.	Vanos	University of Guelph
Elisabeth	Viktor	McGill University
Qiang	Wang	University of Alberta
Robin	Wilson	Dalhousie University
Dejian	Yang	University of Northern British Columbia
Waqar	Younas	University of Northern British Columbia

Guidelines for Presenters and Session Chairs

Oral presentations

Presenters

Please ensure the electronic file name of your presentation includes the session number, paper number and presenter name. We will have volunteers in the session room 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 2010 / 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. Any links should be checked at the meeting to ensure that they remain functional. There will be a computer in the Speaker Preparation room where speakers can test drive their presentations.

Session Chairs

One Congress assistant will be present in the session room. The assistant will be available to help with any A/V or computer technical problems. Each computer will be equipped with the following software: Microsoft Office 2010, 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.

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 can 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.

Poster Sessions and Exhibits

Posters and exhibits will be located in Carson Hall on the second level of the Victoria Conference Centre, which is also the location of Congress coffee breaks. The posters and exhibits will be on display for the duration of the Congress.

Poster Session Schedule:

Day 1 and 2 Science Sessions - Monday, June 6th 16:00 – 17:30
Day 3 and 4 Science Sessions - Wednesday, June 8th 15:30 – 17:00

Poster presenters:

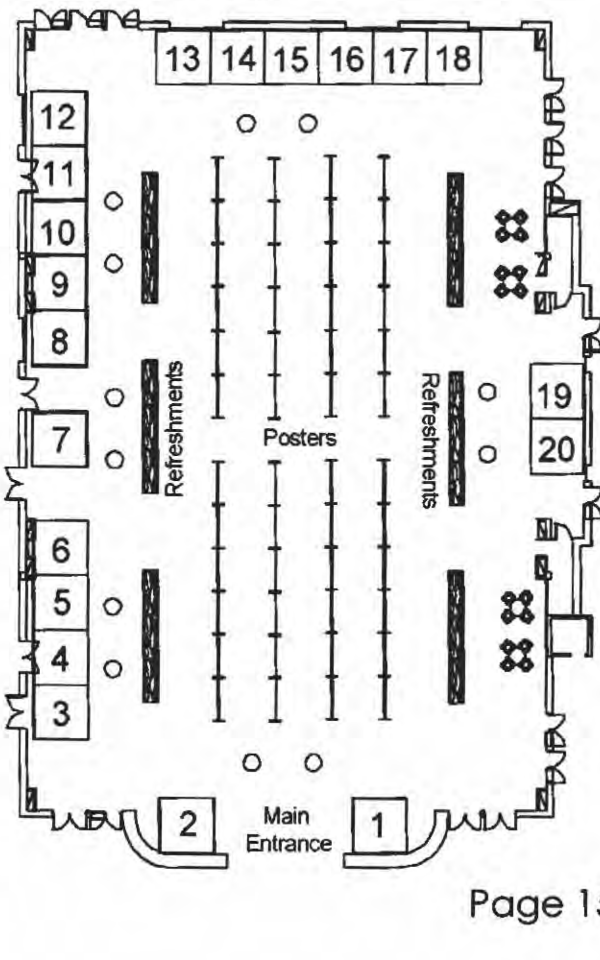
Each poster is allocated a space of approximately 4 ft (1.2 m) by 4 ft (1.2 m). The poster boards can accept both Velcro and pins (a supply of both will be available). Posters can be mounted any time after 10:00am on Monday. Presenters should attend their posters during the assigned poster session. Posters should be removed by the end of the afternoon refreshment break on Thursday.

Exhibitors:

We encourage delegates to visit the booths of our diverse range of exhibitors from industry, government and academia.

Booth	Name
1	CMOS
2	Info-Electronics Systems Inc.
3	Hoskin Scientific Ltd.
4	ECO Canada
5	Vaisala Inc.
6	Campbell Scientific
7	AXYS Technologies Inc.
8	ASL Environmental Sciences Inc.
9	RBR Pacific
10	COMET
11	Belfort Instrument
12	CBC
13	Geonor Inc.
14	CFCAS
15	JouBeh Technologies Inc.
16	FTS Environmental Ltd.
17	Roper Resources Ltd.
18	ATS Technology Systems Inc.
19-20	NEPTUNE-VENUS

Carson Hall



Public Lectures

Held in the VCC Main Lecture Theatre, 19:30-20:30

Tuesday June 7, 2011

"The North Pacific - An Ocean in Transition"

Dr. Ken Denman
Chief Scientist Venus Network
University of Victoria and Environment Canada

Ken Denman is Professor in the School of Earth and Ocean Sciences and Chief Scientist of the VENUS Coastal Network, as well as emeritus scientist at the Canadian Centre for Climate Modelling and Analysis of Environment Canada, all at the University of Victoria. He spent many years as a research scientist at the Institute of Ocean Sciences near Victoria and previously at the Bedford Institute of Oceanography in Halifax, both with Fisheries and Oceans Canada.
Ken's research interests include studying the dynamics of planktonic ecosystems and their role in the ocean carbon cycle in a changing climate. Most recently he has been modelling the effects of purposeful ocean iron fertilization to remove carbon dioxide from the atmosphere, and also the increasing acidification of the ocean resulting from the addition of carbon dioxide to the oceans as a result of the burning of fossil fuels. In his spare time Ken especially enjoys cycling and mountaineering.

Thursday June 9, 2011

"Exploring ocean frontiers - we have more to learn"

Dr. Verena Tunnicliffe
Canada Research Chair in Deep Ocean Research
University of Victoria

Verena Tunnicliffe is the Director of the VENUS (Victoria Experimental Network Under the Sea) project, Subsea Observatory and Professor and Canada Research Chair in Deep Sea Oceans at the University of Victoria. She was educated at McMaster University (B. Sc.) and Yale University, where she received her Masters and Ph.D.
Dr. Tunnicliffe's research focuses on the ecology and evolution of hot-vent animals and marine community history. She collaborates widely across many disciplines from geophysics to molecular biology and often does her field work under the waves, having undertaken more than 120 submersible missions to date.

Conference Workshops

All on Wednesday, June 8, 2011

ECO Canada Special Session:

WORKSHOP ON CERTIFICATION FOR METEOROLOGISTS Professional Meteorologist – P. Met

Chair: Grant Trump, ECO Canada

Contact: kbadrov@eco.ca

ECO Canada, in collaboration with CMOS and Environment Canada, has recently completed development on National Occupational Standards (NOS) for Meteorology. Created in consultation with over 300 meteorological professionals nation-wide, the NOS for Meteorology forms the basis for a new certification program for Professional Meteorologists (P. Met). In commemoration of its official launch at the 2011 CMOS Congress, ECO Canada is organizing this special session on certification. This special session will also be conducted in the form of a town hall meeting and discussion panel, involving a number of meteorologists who have been involved in the development of the certification program who will sit as special panelists alongside ECO Canada. This is a great opportunity to learn more about competencies and certification and to ask questions of meteorologists who have been involved in the project. We welcome all attendees at the 2011 CMOS Congress.

WHERE: Sidney Room **WHEN: Wednesday June 8, 16:30 – 18:00.**

HRDPS Workshop:

Discussion of Users' Needs for an Operational High Resolution Deterministic Prediction System

Chair: Jason Milbrandt, Environment Canada

Contact: jason.milbrandt@ec.gc.ca

Over the past several years, the Canadian Meteorological Centre has run a set of experimental, 2.5-km grid-spacing, limited-area, GEM forecast grids over various regions of Canada. In the near future, the system will be given formal "operational" status and will thus constitute an official CMC forecast product. There is a large number of users of the current system and their needs and applications are varied. In order to most effectively steer research and development of the system, and to help design new configurations that best satisfy the clients' needs within the confines of the computational constraints, current and potential users/clients of the 'GEM-LAM-2.5 system' are invited to participate in this discussion session in order to communicate their specific needs and requests for an operational system.

WHERE: Saanich 1 Room **WHEN: Wednesday June 8, 16:30 - 18:00.**

Conference Workshops

All on Wednesday, June 8, 2011

NSERC Competition Results and "How to prepare a Discovery Grant application"

Chair: Dave Bowen

Contact: Dave.bowen@nserc-crsng.gc.ca

NSERC Research Grants staff will provide an overview of Program news and results of the 2011 Discovery Grants competition. In addition, a workshop will cover the Notification of Intent to Apply (Form 180) process, the Discovery Grant evaluation process (principles, criteria, & ratings), the Conference Model, and tips for preparing a Discovery Grant application. An Evaluation Group member will also be present to share their experience and knowledge of the evaluation process. There will be an opportunity for questions during and after the presentation.

WHERE: Oak Bay 2 Room **WHEN: Wednesday June 8, 16:30 - 18:30.**

Ocean Hypoxia Town Hall

Chair: Damian Grundle, University of Victoria

Contact: dgrundle@uvic.ca

Reports of new and expanding areas of oxygen depletion in coastal and oceanic regions are increasing. One of the proposed underlying causes for this increase is climate change. This Town Hall meeting will address this topic. This will follow the June 7 CMOS scientific session *Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses*. The Town Hall discussion will begin by considering recent research and ideas on links between climate change and hypoxia, and will progress towards evaluating the need and urgency for further research, and our capacity in Canada to contribute to this research through inputs from many disciplines, programs and institutions. Organizations contributing to this discussion will include the Pacific Institute for Climate Solutions (PICS), and the VENUS and NEPTUNE Canada ocean observatories. We invite all who are interested in taking part in this discussion to join us.

WHERE: Esquimalt Room **WHEN: Wednesday June 8, 16:30 - 18:00.**

Educators' Day

Monday, June 6, 2011
8:30 – 16:30
Plenary: Sidney Room
Workshops: Colwood and Metchosin Rooms

OCEAN NETWORKS CANADA
A University of Victoria Initiative

Educators' Day is a chance for teachers and other educators to experience an engaging and interactive day of educational ideas and activities related to meteorology, climatology, oceanography, forecasting, climate change, and so much more! Learn directly from professionals and researchers in these fields on how to increase ocean-atmosphere literacy, ways to incorporate real-time data, and hands-on activities for your curriculum and program planning.

Lunch is included for registrants of Educators' Day. Other CMOS delegates are welcome to sit in sessions if space permits.

8:30 – 8:45	Welcome and Opening – Sidney Room **Lisa Vitols**, *Environment Canada* & **Krista Zala**, *Ocean Networks Canada* **Sheila Bourque**, *Director, Education and Outreach, CMOS*
8:45 – 9:30	Plenary: Education and the Changing Pacific – Sidney Room Panelists: **Jeff Hopkins**, *School District 64 (Gulf Islands)* Laura Verhegge, *Lester B Pearson College of the Pacific (invited)* **Cynthia Korpan**, *Let's Talk Science*
9:40 – 10:25	Making it Real - Principles of Ocean/Climate Literacy Climate/Atmosphere – Colwood – **Andrew Weaver**, *UVic* Oceans – Metchosin – **Rick Searle**, *Ocean Networks Canada*
10:25 – 10:45	Break
10:45 – 11:30	Using Real-Time Data in the Classroom and Beyond Oceans – Metchosin / Atmosphere – Colwood
11:40 – 12:25	Hands-On Learning Oceans– Metchosin – **Anne Stewart**, *Bamfield Marine Sciences Centre* Atmosphere– Colwood – **Hamish Murray**, *Environment Canada*
12:25 – 13:15	Lunch (provided for Educators' Day registrants)
13:15 – 14:00	Joint Workshop: What are the Toughest Things to Teach? – Colwood **Eileen Van der Flier-Keller**, *UVic*
14:00– 14:45	The Extreme Pacific – Colwood **Adam Monahan, Robin Matthews, et al**, *University of Victoria*
14:45 – 15:05	Break
15:05 – 15:50	The Art and Science of Oceans and Climate – Colwood **Remy Rodden**, *www.thinkabout.ca and www.StudentsonIce.com*
15:50 – 16:30	Closing Plenary: **Dr. Rick Kool**, *Royal Roads University* – Colwood

Plenary Speakers

Monday, June 6, 2011

Dr. Clara Deser
National Center for Atmospheric Research

Clara Deser is senior scientist in the Climate Analysis Section of the Climate and Global Dynamics Division at the National Center for Atmospheric Research (NCAR). Dr. Deser's research encompasses a broad range of topics relating to analysis of observed and modelled climate variability and change in the coupled atmosphere-ocean-ice system. Recently these have included mechanisms of Antarctic climate variability, the response of Arctic and global climate to Arctic sea ice loss, and the contribution of unforced climate variability to uncertainty in projections of future climate change.

Dr. Randall Martin
Dalhousie University

Randall Martin is the Killam Professor in the Department of Physics and Atmospheric Science at Dalhousie University, and a Research Associate at the Harvard-Smithsonian Center for Astrophysics. He serves as deputy model scientist for a widely-used global model of atmospheric composition (GEOS-Chem). He was recently the scientific co-chair of the IGAC/iCACGP international conference on atmospheric chemistry. He has published more than 70 peer-reviewed journal articles on satellite remote sensing and global modeling of atmospheric composition.

Plenary Speakers

Tuesday, June 7, 2011

Dr. Peter Brewer
Monterey Bay Aquarium Research Institute

Peter Brewer is an ocean chemist, and Senior Scientist, at the Monterey Bay Aquarium Research Institute (MBARI). He has taken part in more than 40 deep-sea cruises, has served as Chief Scientist on well over 100 ROV dives, and on major expeditions worldwide. Dr. Brewer's research interests are broad, and include the ocean geochemistry of the greenhouse gases. At MBARI his current interests include the geochemistry of gas hydrates, the bio-geochemical impacts of the growing oceanic fossil fuel CO_2 signal, the multiple impacts of ocean acidification, and the development of in situ laser Raman spectrometry techniques for real-time measurement in the deep-sea.

Dr. Phil Mote
Oregon Climate Change Research Institute,
Sponsored by the Pacific Climate Impacts Consortium

Phil Mote serves as director of the Oregon Climate Change Research Institute (OCCRI) at Oregon State University. Dr. Mote's research interests include climate variability and change in the Pacific Northwest, mountain snowpack and its response to climate variability and change, and interpretation of global model and satellite data as well as impacts of climate change on water resources, forests and shorelands, sea level rise, and adaptation to climate change. His recent research work includes regional modeling with massive ensembles using volunteer computing, optimal design of surface climate observing networks, finescale variability of surface temperature, and satellite observations of tropical climate variability and feedbacks.

Plenary Speakers

Wednesday, June 8, 2011

Dr. Shin-ichi Ito
Tohoku National Fisheries Research Institute
PICES Plenary Lecture

Shin-ichi Ito is Chief Scientist of the Physical Oceanography Section in the Fisheries Research Agency of Japan's Tohoku National Fisheries Research Institute. His main research interest is the relation between ocean properties and circulation and marine ecosystems, particularly in the subarctic Oyashio Current and mixed water region where it collides with the warm Kuroshio Current east of Japan. Dr. Ito is Co-Chairman of the GLOBEC Ecosystem Studies of Sub-Arctic Seas Working Group on Modeling Ecosystem Response.

Dr. David Battisti
University of Washington

David Battisti is the Tamaki Endowed Chair of Atmospheric Sciences at the University of Washington. He is especially interested in understanding how the interactions between the ocean, atmosphere, land and sea ice lead to variability in climate on time scales from seasonal to decades. His previous research includes coastal oceanography, the physics of the El Niño/Southern Oscillation (ENSO) phenomenon, midlatitude atmosphere/ ocean variability and variability in the coupled atmosphere/ sea ice system in the Arctic. Dr. Battisti has worked to identify the mechanisms responsible for the drought cycles in the Sahel, and to better understand the monsoon circulations, and is also working on impacts of climate variability and change on food production in Mexico, Indonesia and China. Dr. Battisti's recent interests in paleoclimate include mechanisms responsible for the remarkable "abrupt" global climate changes evident throughout the last glacial period.

Plenary Speakers

Thursday, June 9, 2011

Dr. Jim McWilliams
University of California at Los Angeles (UCLA)

Jim McWilliams is the Louis B. Slichter Professor of Earth Sciences in the Department of Atmospheric and Oceanic Sciences and the Institute for Geophysics and Planetary Physics at UCLA. Dr. McWilliams' primary areas of scientific research are the fluid dynamics of Earth's oceans and atmosphere, both their theory and computational modeling. Recently he has been involved in developing a three-dimensional simulation model of the U.S. West Coast that incorporates physical oceanographic, biogeochemical, and sediment transport aspects of the coastal circulation. This model has been used to interpret coastal phenomena, diagnose historical variability in relation to observational data, and assess future possibilities.

Dr. Thomas Stocker
University of Bern
Sponsored by the Pacific Institute for Climate Solutions

Thomas Stocker has been a Professor of Climate and Environmental Physics at the University of Bern since 1993. His research encompasses the development of climate models of intermediate complexity, modelling past and future climate change and the reconstruction of the chemical composition of precipitation and greenhouse gas concentrations based on ice cores from Greenland and Antarctica. He was awarded a Dr. Honoris Causa of the University of Versailles (France) in 2006 and the Hans Oeschger Medal of the European Geosciences Union in 2009. After more than 10 years of service in the UN Intergovernmental Panel on Climate Change (IPCC) he was elected Co-Chair of Working Group I "The Physical Science Basis" of the IPCC in 2008.

Scientific Session Descriptions

Atmosphere

Clouds, Aerosols and Radiation
Jason Cole, Jiangnan Li, Knut von Salzen

Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: Knut.VonSalzen@ec.gc.ca

Clouds, aerosols and radiation each affect Earth's climate and weather and remain a challenge to observe and model, especially interactions that couple them. More complex methods to simulate these processes and interactions are increasingly being used in climate, numerical weather prediction, and air quality models. The development of these more complex parameterizations as well as more comprehensive observational data sets pose substantial challenges to the modelling and observational communities. This session welcomes contributions addressing the development and application of new modelling results to issues in climate, numerical weather prediction and air quality. Contributions addressing observational data sets will include in-situ, ground-based and satellite-based observations, and the use of these data sets to evaluate models.

Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10)
G.A. Isaac, Paul Joe

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

A World Meteorological Organization project entitled the Science of Nowcasting Olympic Weather for Vancouver 2010 gathered data during the recent Vancouver 2010 Olympic and Paralympic Winter Games. The goal of SNOW-V10 is to improve our ability to produce short term or Nowcasts (within 6h) of high impact winter weather over complex terrain, including parameters such as precipitation rate and type, visibility, cloud base, and wind gusts. The enhanced observing network developed for the Olympics was augmented by special research equipment. Research numerical forecast models developed for this area were evaluated in real time. Some innovative Nowcast systems were also developed and tested. This session will focus on all aspects of SNOW-V10, including studies of meteorological processes documented during the Games, the value of the research instrumentation, and the accuracy of the forecasts and their usefulness to users.

Developments and applications of the GEM-LAM and the High Resolution Deterministic Prediction System
Jason Milbrandt

RPN, Environment Canada
Contact: jason.milbrandt@ec.gc.ca

For the past several years, the Canadian Meteorological Centre (CMC) has been running the Global Environmental Multiscale (GEM) model over several high-resolution (2.5 km grid spacing) limited-area model (LAM) domains in Canada in real-time, experimental mode. In support of forecasting for the 2010 Vancouver Olympics, a special configuration of the GEM-LAM was run and was shown to be very skillful at forecasting high-resolution meteorological phenomena. This test configuration will form the basis for next major upgrade to the GEM-LAM-2.5 system. Further, the system will move from experimental to operational status in the near future. This modelling system -- now referred to as the High Resolution Deterministic Prediction System (HRDPS) -- is used more and more by operational CMC forecasters and the GEM-LAM is used increasingly by researchers throughout the country, both within Environment Canada and universities.

As computer power continues to increase, high-resolution atmospheric modelling in Canada is becoming increasingly important, both in research and in operational numerical weather prediction. The purpose of this session is for researchers, developers, and users to present recent work related to model development and specific applications of the GEM-LAM and the HRDPS.

Science in Support of Air Quality Management
Xin Qiu[1], *Robert Nissen*[2]

[1] Novus Environmental Inc.
[2] Environment Canada
Contact: xing@novusenv.com

Air pollution is a global problem that causes premature mortality and morbidity, damages crops and ecosystems, and contributes to climate change. Furthermore, air pollution does not respect jurisdictional boundaries and is affected by sources and processes over local, regional, intercontinental, and global scales. In North America, poor air quality is estimated to cause tens of thousands of deaths and cost society more than $100 billion annually. Recent scientific and technical advancements, including new observing and information technologies and insights into atmospheric processes, have created opportunities to better assess and manage air pollution and its impacts. Improved information about air quality enables policy-makers and environmental managers to develop more effective policies and plans to improve public health and well being, protect critical ecosystems, and maintain a vital economy. Enhanced air quality forecasts allow communities and individuals, especially those suffering from asthma, allergic diseases, cardiovascular disease, or pulmonary disease, to more effectively limit exposure and the adverse effects of poor air quality.

New Avenues in Forecast Verification
Laurence Wilson

Meteorological Research Division, Environment Canada
Contact: lawrence.wilson@ec.gc.ca

Objective forecast verification has traditionally been carried out by comparing forecasts at points with point observations, and summarizing the result into values of one or more "scores". To the extent that the emphasis has often been on upper air variables, and the comparison done with respect to analyses rather than observations, the output of traditional verification has arguably been more of use to those who work in the development of models than to any other user group.

Recently there have been two important overlapping thrusts in the field of verification research and practice, which might be labelled "User-oriented verification" and "spatial verification". "User-oriented verification" refers to any verification practice where the needs of specific users or user groups are considered in the design of the verification methodology, whether standard or experimental methods are used. "Users" may be the intended users of the verification results, "modelers" or "forecasters" for example, or the user community for the forecasts being verified. "Spatial verification" techniques focus on the assessment of coherent spatial structures such as precipitation areas or frontal systems, as they are represented in the forecast or model being verified.

Papers which illustrate new ideas in verification and their application, as motivated by the needs of users, relating to all forecast ranges, and papers which illustrate the application of verification methods consistently across forecast time ranges from days to seasons are expected.

Weather Services
Nicole Bois

Environment Canada
Contact: nicole.bois@ec.gc.ca

This session will give you an update on the strategic and operational direction of different MSC service offerings. From technological transfer from research to operations, through the overall services strategy and communication to clients, to our role and services in the environmental emergency situations such as the recent Icelandic volcanic event or the Japanese tsunami and related radioactivity issues.

Scientific Session Descriptions

Numerical Weather Prediction: Modelling
Bertrand Denis

Environment Canada
Contact: bertrand.denis@ec.gc.ca

This session will showcase the recent developments of numerical weather prediction models, with a focus on those currently running operationaly at CMC or being soon implemented. A performance evaluation of a such operational CMC NWP model will be presented. This session will also cover the efforts made to improve the numerical methods and to better adapt and optimize model codes in order to run these models in an efficient way.

Numerical Weather Prediction : Post-processing
William Burrows

Environment Canada, S&T Branch, ARMP/HAL
Contact: william.burrows@ec.gc.ca

This session deals with methods and procedures for forecasting weather elements not directly output by operational NWP models. Presentations include SCRIBE production of worded nowcasts from GEM output, gene-expression programming to improve precipitation forecasts in mountainous terrain, the use of recent observations to update probabilistic forecasts, using total lightning observations for predicting severe storms, and a rule-based model to generate national fog/stratus forecasts from GEM Regional output.

General Atmospheric Sciences
Steven Lambert

Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: steve.lambert@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, and meteorological training programs.

Oceanography

Ocean Processes over Topography
Susan Allen[1], Blair Greenan[2]

[1] Earth and Ocean Sciences, University of British Columbia
[2] Bedford Institute of Oceanography
Contact: sallen@eos.ubc.ca

Topography on the scale of underwater canyons, ridges and seamounts affects large scale exchange between the open ocean and the coastal ocean. Within the coastal ocean topography such as banks, sills, and headlands cause distinct flow regimes. Both types of topography lead to regions of enhanced currents, vertical advection and mixing which means they are also regions of enhanced biological productivity and aggregation of plankton.

Remote Sensing and Oceans
Helen Joseph

Fisheries and Oceans Canada
Contact: Helen.Joseph@dfo-mpo.gc.ca

Remote sensing capabilities continue to expand and provide increasingly effective means to observe oceans. Used either on their own or in combination with more traditional means of ocean monitoring, remote sensing can provide innovative means of monitoring oceans. Papers on new remote sensing technologies and applications (including satellites, Automated Underwater Vehicles, etc) on both physical and biological monitoring of oceans are expected in this session.

Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses
Kim Juniper[1], Denis Gilbert[2], Damian Grundle[1]

[1] University of Victoria
[2] Institut Maurice Lamontagne
Contact: kjuniper@uvic.ca

Worldwide, and throughout much of the Pacific, reports of new and expanding areas of oxygen depletion in coastal and oceanic waters are of concern to marine scientists and the general public. Permanent and seasonal hypoxic zones can have multiple causes that are sometimes concurrent. Consequences of hypoxia for fisheries and ecosystem processes are potentially serious but remain incompletely understood. Ocean biogeochemical processes are also strongly influenced by the availability of dissolved oxygen and these in turn can feed back to influence nutrient availability, marine productivity and even the production of greenhouse gases in the ocean. Papers will address any of the various facets of the hypoxia problem, from physical controls through to biogeochemical and ecological causes and consequences.

Mixing in stratified shear layers

Ali Mashayek[1], *William Smyth*[2]

[1] Physics Department, University of Toronto
[2] Professor, College of Oceanic & Atmospheric Sciences, Oregon State University
Contact: amashaye@atmosp.physics.utoronto.ca

This session responds to mixing in stratified shear layers. The goal is to gain a better understanding of the ocean turbulence by studying the details of the dynamics and energetics and their consequences for mixing efficiency. One of the main goals of the related studies is to improve the parametrizations used in numerical models. The session is focused on diapycnal mixing processes, including both shear-driven turbulence and double diffusive instabilities. Specific topics of interest include, but are not limited to: routes of transition to turbulence, the efficiency of mixing, interaction between instabilities observed in shear layers and internal waves, parametrizations used for shear mixing in Ocean circulation models etc.

Acoustics in Oceanography

Tetjana Ross[1], *Len Zedel*[2]

[1] Dalhousie University, Halifax, NS
[2] Memorial University of Newfoundland, St. John's, NL
Contact: tetjana@dal.ca

Acoustic techniques are the only means of long distance communication and remote sensing underwater. Consequently, acoustics is key to revealing the underwater world. 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, defense applications, ambient noise, long-range propagation, high-frequency scattering, imaging and quantitative inversion.

Coastal Oceanography and Inland Waters

Jinyu Sheng[1], *Guoqi Han*[2], *Ram Yerubandi*[3]

[1] Department of Oceanography, Dalhousie University
[2] Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada
[3] National Water Research Institute, Environment Canada
Contact: jinyu.sheng@dal.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 invited contributions related to both observational and modelling aspects of biogeochemistry in coastal and inland waters.

Celebrating the Scientific Career of Daniel G. Wright

Charles Hannah[1], *John Loder*[1], *Lawrence Mysak*[2], *Keith Thompson*[3]

[1] Bedford Institute of Oceanography
[2] McGill University
[3] Dalhousie University
Contact: keith.thompson@dal.ca

Dan Wright started his oceanographic career as a graduate student at UBC in 1975, followed by postdoctoral positions at Woods Hole Oceanographic Institution and Dalhousie University. He moved to the Bedford Institute of

Oceanography in 1981 where he was a leading research scientist until his untimely passing on 8 July 2010. Dan was a highly productive, generous and respected scientist, colleague and mentor to many scientists from Canada and abroad.

This session will celebrate Dan Wright's multi-faceted research career through invited presentations and a selection of contributed talks. The invited talks will cover (i) theoretical studies of shelf circulation and sea level variability, (ii) ocean climate models of intermediate complexity, (iii) modelling and observational studies of basin and global scale ocean circulation, and (iv) recent advances in the equation of state for sea water. Contributed talks are encouraged from scientists, postdoctoral fellows and students who have collaborated recently with Dan Wright.

General Oceanographic Sciences
Nadja Steiner

Institute of Ocean Sciences and Canadian Centre for Climate Modelling and Analysis, EC
Contact: nadja.steiner@ec.gc.ca

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

Climate

George Boer Session on Climate Modelling and Analysis
Vivek Arora, Greg Flato

Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: vivek.arora@ec.gc.ca

This special CMOS session will recognize the outstanding research contributions of Dr. George Boer to the field of climate modelling and analysis. During a career that spans more than 40 years Dr. Boer's research activities have produced significant achievements in a variety of fields including analysis of the large-scale atmospheric circulation, climate variability, climate sensitivity, medium and long range prediction and, more recently, carbon-climate interactions.

New CMOS Undergraduate Scholarship in Memory of Dr. Dan Wright

A new CMOS undergraduate scholarship has been created in memory of Dr. Dan Wright, who passed away suddenly in July 2010. Dr. Wright was a senior research scientist at DFO's Bedford Institute of Oceanography, as well as an Adjunct Professor at Dalhousie University, for many years prior to his passing. In his outstanding career as an eminent physical oceanographer, Dr. Wright was highly productive, a generous and respected scientist, and an advisor, colleague and friend to many in the oceanographic and atmospheric research communities. In particular, he cherished the opportunity to interact with students and young scientists, which is the motivation for honouring his memory through an Undergraduate Scholarship. A complete summary of his many accomplishments and honours appeared in the CMOS Bulletin SCMO (vol. 38, No. 4) in August 2010.

The new CMOS Undergraduate Scholarship named in honour of Dan Wright, in the amount of $1,000, will be awarded to a Canadian undergraduate student entering his/her final year of a B.Sc. Honours program in Mathematics and/or Physics, or a related discipline, at a Canadian university. The successful candidate will be selected on the basis of: his/her academic standing; a demonstrated interest in pursuing graduate studies in physical oceanography or a related field of study; and the ability and interest to communicate and share his/her knowledge with others, as indicated in his/her resume and/or letter(s) of reference. CMOS intends to offer this new undergraduate scholarship for at least the next five years, or longer as donations allow. Donations for the new CMOS Undergraduate Scholarship in Dan Wright's memory can be made to the Scholarship Fund of the Canadian Meteorological and Oceanographic Society (CMOS). A donation form can be found on the CMOS website.

Validation of empirical-statistical downscaling methods in a varying climate system
Alex Cannon[1], Trevor Murdock[2], Yonas Dibike[3]

[1] Meteorological Service of Canada
[2] Pacific Climate Impacts Consortium
[3] Environment Canada
Contact: alex.cannon@ec.gc.ca

In the face of climate variability and change, local and regional decision makers are increasingly being asked to incorporate information about future climate scenarios in their planning decisions. Empirical-statistical downscaling (ESD) methods, which link outputs from Global Climate Models to station climate observations via statistical relationships, offer a computationally efficient means of providing this information. Since the introduction of the ESD approach, a large body of methods has been developed for climate downscaling purposes. Regardless of method, however, a fundamental assumption is that the statistical relationships linking the large-scale climate to the local scale remain valid under future climate conditions. Given a changing climate system, how does one verify that this assumption holds? This session is devoted to addressing this and related questions. Can ESD methods be validated on historical data in such a way that decision makers can have confidence in their predictions for the future? What metrics should be used to verify the performance of ESD methods at a range of spatial and temporal scales? Can the sensitivity of ESD methods to decisions about predictors, model parameters, etc. be constrained in an intelligent fashion? How do ESD and Regional Climate Model projections compare?

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 and intensity 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 and historical trends analysis of the extreme events is essential for decision makers to develop adaptation strategies and policies. This information includes quantitative assessments or projections on changes in frequency and intensity of the meteorological and hydrological extreme events under a changing climate. This session invites submissions of papers concerning historical trends analysis of and 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, blizzards, snow on the ground, 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.

The role of the stratosphere in weather, climate and climate change

Nathan Gillett[1], *Mark Baldwin*[2], *Norm McFarlane*[3], *Paul Kushner*[4]

[1] CCCma, Environment Canada
[2] Northwest Research Associates, Seattle, WA, USA.
[3] SPARC International Project Office, University of Toronto
[4] Department of Physics, University of Toronto
Contact: nathan.gillett@ec.gc.ca

This session will focus on stratosphere-troposphere dynamical, radiative, and chemical coupling processes on a range of time and space scales that affect weather, climate and climate change. These topics fall largely within the scope of the WCRP SPARC (Stratospheric Processes and their Role in Climate) program. Themes considered will include climate-chemistry interactions; detection, attribution, and prediction of stratospheric change; stratosphere-troposphere dynamical coupling; and the role of the stratosphere in polar climate and polar climate change.

Climate prediction and predictability

Slava Kharin[1], *Youmin Tang*[2]

[1] CCCma, Environment Canada
[2] University of Northern British Columbia, Prince George, BC
Contact: slava.kharin@ec.gc.ca

The basis for climate prediction is that relatively slow variations in weather statistics can be predicted with at least modest skill at lead times for which specific weather events have ceased to be predictable. Phenomena giving rise to such potentially predictable variations on longer time scales include the Madden Julian Oscillation (weeks), El Nino-Southern Oscillation (seasons) and possibly slow components of sea surface temperature variability in the North Pacific and Atlantic Oceans (years). Additional boundary influences, such as soil moisture, snow and sea ice may also play a role. This session welcomed contributions addressing climate prediction by dynamical models or other means, as well as natural limits to climate predictability.

Low-frequency variability and predictability

Hai Lin[1], *Bin Yu*[2]

[1] Meteorological Research Division, Environment Canada
[2] Climate Research Division, Environment Canada
Contact: hai.lin@ec.gc.ca

This session invited 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 welcomed were 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.

Ocean Responses to Climate and Environmental Change

Paul Lyon

Fisheries and Oceans Canada
Contact: Paul.Lyon@dfo-mpo.gc.ca

Ocean change at the global, regional and local scale is increasingly evident. Ocean acidification, fertilization (euthophication), hypoxia, etc. can potentially alter community structures and food webs in the coastal and ocean, and as a result, degrade and damage ecosystems and fisheries. Biological and geochemical papers in this session describe field observations, laboratory experiments, paleo-oceanographic studies and model studies in high latitude oceans.

Climate change and the carbon cycle

Damon Matthews[1], *Kirsten Zickfeld*[2]

[1] Concordia University
[2] Simon Fraser University
Contact: dmatthew@alcor.concordia.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, offering powerful new tools to investigate these issues. Recent research has highlighted the irreversibility of CO2-induced climate change on centennial timescales, the path-independence of CO2-induced temperature change, and the resulting policy implications.

Canada's modelling contribution to the IPCC 5th assessment

Greg Flato, *William Merryfield*

Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: greg.flato@ec.gc.ca

Modelling activities relating to the 5th assessment of the Intergovernmental Panel on Climate Change (IPCC/AR5) are in full swing worldwide. These activities are coordinated through a project of the World Climate Research Programme called the Coupled Model Intercomparison Project Phase 5 or CMIP5. This experiment is extending past efforts in two important respects. First, many of the contributing models now include an interactive carbon cycle, so that the climate system's response to emissions of CO2 and other greenhouse gases can be explored. Alternatively, such models allow CO2 emissions to be diagnosed from experiments in which greenhouse gas concentrations are specified; in either case, potentially important carbon-cycle feedbacks, including those involving terrestrial and oceanic ecosystems, can be simulated. A second new component of CMIP5 is the application of climate system models to predicting climate trends and variability over the next 10-30 years by means similar to those employed in weather and seasonal climate prediction, i.e. by incorporating climate observations into model initial states. This session will provide an overview of CMIP5 and the Canadian modelling efforts that are contributing to it, and presentations relating to the IPCC 5th assessment.

Application of Climate Model Results to Regional Adaptation
Arelia Werner, *Gerd Buerger*

Pacific Climate Impacts Consortium
Contact: wernera@uvic.ca

Over the last decade, various community and business groups across Canada and elsewhere have aspired to consider climate change impacts in their planning practices. In this regard, British Columbia (BC) is quite challenging due to oceanic and topographic influences that complicate climatic impact considerably, especially the impact on hydrology. This complication is beyond the scope of most stakeholders, so that universities, government agencies, institutes and consortiums have taken up the challenge. As a result, many skills pertinent to this field have advanced including; climate model selection and adjustment, 'downscaling' of model fields (statistical and dynamical), characterization of uncertainty, and subsequent hydrologic modeling. For this session we invite presentations on recent work in these areas. We will emphasize projects that take into consideration the full model chain from global climate models to applying downscaled projections to impact models, and the propagation of uncertainty through these models. The results should be practical for the planning purposes in the fields of water, energy, forestry, and municipal planning.

Soil Moisture, Streamflow, and Hydrologic Impacts of Climate Change
Vivek Arora

Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: Vivek.Arora@ec.gc.ca

This session will examine aspects of hydrologic science relating to soil moisture and streamflow, including field experiments, data assimilation for weather and climate prediction, and the nature and impacts of changes caused by unforced climate variations and anthropogenic climate change.

Atmosphere-Ocean-Ice Interface

Remote Sensing of the Ocean Surface - Synthetic Aperture Radar
Chris Fogarty[1], *Vladimir Zabeline*[2]

[1] National Lab for Marine and Coastal Meteorology / Canadian Hurricane Centre
[2] Canadian Ice Service
Contact: chris.fogarty@ec.gc.ca

Synthetic Aperture Radar (SAR) provides a detailed view of a variety of phenomenon and features ranging from the wind field of the atmospheric boundary layer, to sea ice tracking, to iceberg detection, to ocean currents and waves. With efforts being made toward operationalization of SAR-based winds at the Meteorological Service of Canada, there will be a growing level of interest in the imagery among meteorologists and oceanographers. Imagery from SAR for monitoring sea ice has been occurring at the Canadian Ice Service for many years now using RADARSAT-1. The newer RADARSAT-2 platform now offers opportunity for more advanced monitoring of the ocean surface with its various programmable modes. The Sentinel-1 and RADARSAT Constellation Missions offer the further promise of more frequent observations and data continuity, and other SAR sensors are expected as well. This session will present an opportunity for various atmosphere and ocean disciplines to get together and learn about SAR theory and applications.

Modelling and analysis of atmosphere and ocean dynamic processes

Youyu Lu[1], *Jianping Gan*[2], *Hai Lin*[3]

[1] Bedford Institute of Oceanography
[2] Hong Kong University of Science and Technology
[3] Environment Canada
Contact: Youyu.Lu@dfo-mpo.gc.ca

This session invites presentations of new studies on modelling and analysis of atmosphere and ocean dynamic processes at broad space and time scales. We welcome abstracts on topics related, but not limited, to atmosphere and ocean processes at synoptic to climate scales, in open sea, coastal water and large lakes; air-sea flux estimation and parameterization; model sensitivity experiments and coupled model inter-comparisons. New methods of analyzing observational and modelling datasets, new modelling systems and new development of theoretical framework are also important aspects of this session.

Operational ice-ocean analysis and prediction

Mark Buehner, Tom Carrieres, Greg Flato, Greg Smith

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 can result in significant economic and safety benefits for these activities. Accurate sea-ice and ocean information can also lead to improved numerical weather prediction (NWP) for northern regions, especially when coupled ice-ocean-atmosphere forecast models are used, such as those being developed as part of the inter-departmental initiative CONCEPTS.

Environment Canada and the Department of Fisheries and Oceans are developing objective analysis/prediction approaches for ice-ocean forecasting applications, similar to what is used for NWP. These approaches rely on data assimilation techniques to combine information from observational data 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 and the Climate-system Historical Forecast Project (CHFP). Increasingly, the Nucleus for European Modelling of the Ocean (NEMO) system is being used in Canada for coupled ice-ocean modelling. This session will focus on the components required for the successful development of such operational ice-ocean analysis and prediction systems, including:
1) observations: all aspects of how remotely sensed and in-situ data can provide useful information on sea-ice and ocean variables either by direct assimilation or through the use of a retrieval algorithm;

2) forecast models: all aspects on the development of numerical and statistical sea-ice and ocean models and their application to 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 observations to produce objective estimates of sea-ice and ocean conditions and to provide initial conditions for forecast models.

Scientific Session Descriptions

Atmospheric and Hydrometric Monitoring

Current Operations, Future Direction and Challenges

David Wartman

Atmospheric Monitoring, Environment Canada
Contact: dave.wartman@ec.gc.ca

This session comprises a number of sub-themes. Observations are the foundation for all meteorological and hydrological information, prediction, research, and services. The effort to establish and maintain 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. Snowfall measurement in particular is a key area of interest both domestically and internationally and one in which Canada is assuming a leadership role. Data management is also an integral component of environmental monitoring. The goal of this session is to explore the current and evolving issues and practices in the data end to end process of atmospheric and hydrometric monitoring, and to inform and engage stakeholders on the future of Canada's hydrometeorological monitoring systems. The sub-sessions are:

1. Atmospheric Monitoring Networks and Operations

2. Instrumentation and Technology

3. Snowfall Measurement

4. Space-Based Monitoring

5. Data Management and Services

Interdisciplinary

Climate and carbon cycling in northern terrestrial ecosystems

Pierre Bernier[1], Alan Barr[2]

[1] Canadian Forest Service, Natural Resources Canada
[2] Climate Research Division, Environment Canada
Contact: alan.barr@ec.gc.ca

Northern forests and peatlands ecosystems are coupled to the climate system through the cycling of carbon with the atmosphere, and through their effects on local energy budgets. Their broad spatial extent and large carbon stores make this coupling and its understanding of global importance, both for scoping mitigation efforts and projecting future climate. This session seeks contributions from studies that link climate and the carbon and energy balances of northern forests and peatlands. Topics of interest cover all aspects of this coupling, including the effect of climate variability and change on carbon fluxes in these ecosystems, the larger integrated impacts of changes in these environments on the climate system, including changes in albedo and in latent heat fluxes, the secondary feedbacks linked to broader global changes such as CO2 fertilization, nitrogen deposition or ozone oxidation, as well as the impacts of disturbances such as drought, insects and fires on carbon fluxes and climate. Scales of interest are from local to global and from the minute to the century. Of particular interests are studies that integrate multiple lines of information or ensembles of datasets to produce novel assessments of this biosphere – climate coupling.

Renewable Energy – The Important Role of Meteorological and Oceanographic Sciences

Joel Bedard

Research Assistant, Ecole de technologie superieure, Montreal (Qc), Canada
Contact: joel.bedard@hotmail.com

Due to global warming and the consequences of energy generation, industries and governments are increasingly promoting and developing power generation from renewable sources such as wind, solar, tidal, marine current and hydro power. These types of energy have reduced impacts on the environment compared to the energy generation from more conventional power plants. However, work is still needed to efficiently manage the energy supply according to the demand in the context of a changing environment. Environmental predictions in oceanographic and atmospheric sciences can directly address this important priority by helping the decision makers (power system operators, governments, etc.) to optimize the management of energy resources, to minimize the electrical network balancing costs and to better manage risks related to energy infrastructures. Moreover, environmental predictions play a very important role in the evaluation of the renewable energy resources and in the establishment of the greenhouse gases inventory. Overall, more robust environmental predictions are needed to improve the competitiveness of clean energy systems on the energy market and to help sustaining the integration of such energy sources in electricity portfolios of jurisdictions. Canada has the potential to become one of the world's leaders in renewable energy, therefore it is important to support this sector in order to provide better knowledge and efficient tools to help the decision makers in this area. This session offers an excellent opportunity to present original material addressing the research done in the renewable energy sector with regards to meteorology, hydrology, climatology and oceanography.

Health Issues of Weather and Climate

Denis Bourque

CMOS Member
Contact: denisbourque@rogers.com

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 sought original work studying the relationships between human health (mental and physical) or society's health systems with current and future climates, or studying the relationships between human health (mental and physical) or society's health system with current or future day-to-day weather. We also welcomed 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.

Air Quality Health Index Forecasting and Supporting Science

Dave Henderson and Andrew Teakles

Meteorological Service of Canada, EC
Contact: dave.henderson@ec.gc.ca

The Air Quality Health Index (AQHI) forecasts provide guidance for Canadians to make decisions to reduce their personal risk posed by the air pollution in their communities. These products are issued by Environment Canada forecasters in the five regional Storm Prediction Centres and delivered via the Meteorological Service of Canada's weather dissemination infrastructure. Forecaster guidance is provided by the twice-daily model runs from GEM-MACH, an air chemistry hemispheric model from the Canadian Meteorological Centre (CMC). Additional guidance is provided to forecasters in the form of air quality monitoring data, various specialized statistical model products to name but two. In this session, the oral and poster presentations will highlight the operational aspects of AQHI forecasting, the science associated with the development and provision of guidance products to assist forecasters. Abstracts will describe case studies of interest, supporting innovative scientific and statistical techniques, and new technologies for determining air pollution concentrations from space.

Scientific Session Descriptions

Physical-Biological Interactions in Aquatic Environments

Tetjana Ross[1], _Debby Ianson_[2]

[1] Dalhousie University, Halifax, NS
[2] Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, BC
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 and biology/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)

Atmosphere, Ocean, and Climate Dynamics

Marek Stastna[1], _Adam Monahan_[2], _Ron McTaggart-Cowan_[3]

[1] University of Waterloo
[2] University of Victoria
[3] Environment Canada
Contact: mmstastn@uwaterloo.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 perspecive to be included. Other sessions exist for addressing operational issues, numerical modelling, and the aquisition 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.

Downtown Victoria

La Société canadienne de météorologie et d'océanographie
Canadian Meteorological and Oceanographic Society
American Meteorological Society





46e congrès SCMO | 46th CMOS Congress
25th Conference on Weather Analysis and Forecasting
21st Conference on Numerical Weather Prediction

Canadian Meteorological and Oceanographic Society
La Société Canadienne de Météorologie et d'Océanographie

L'Environnement en évolution et son impact sur les services pour le climat, les océans et la météo

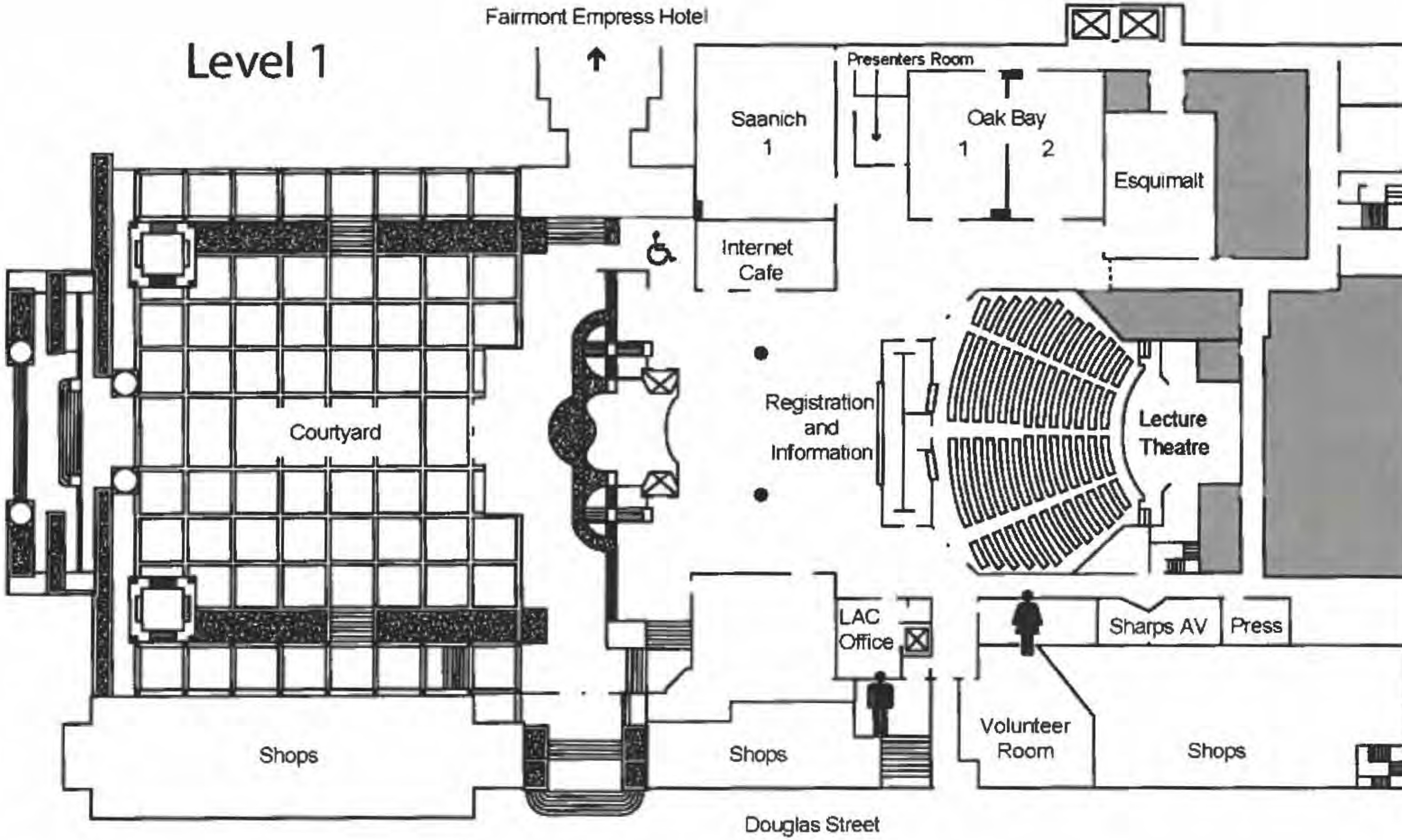
The Changing Environment and its Impact on Climate, Ocean and Weather Services

American Meteorological Society 1919

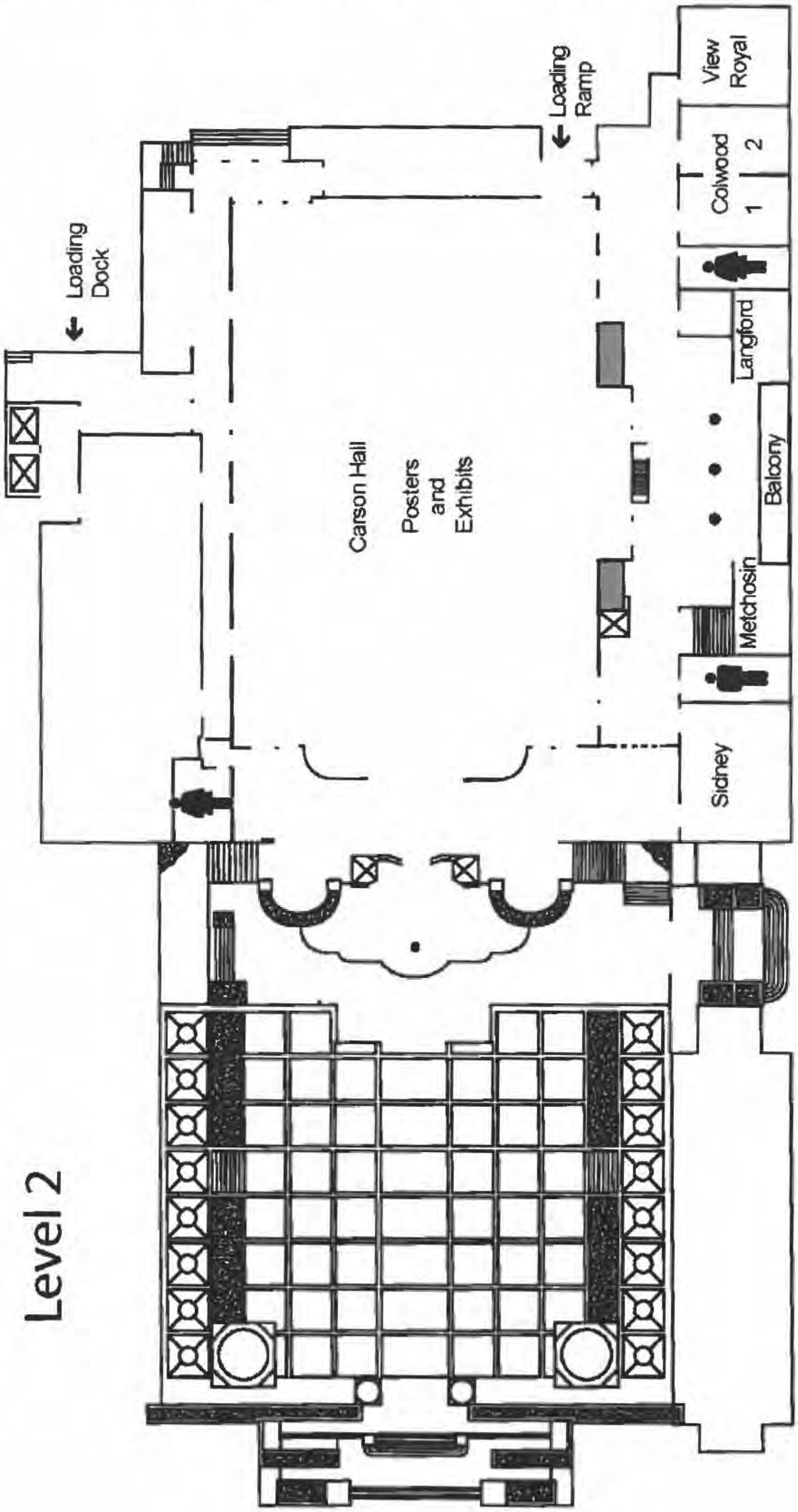
Montréal 2012
29 mai - 1er juin | May 29 - June 1

Victoria Conference Centre Level 1

Level 1



Victoria Conference Centre Level 2



WEEK-AT-A-GLANCE / APERÇU DE LA SEMAINE
SCHEDULES / HORAIRE DES SESSIONS

45th CMOS CONGRESS
45e CONGRÈS DE LA SCMO
VICTORIA 2011

ISBN: 978-0-9732812-9-3

Many thanks to/Merci beaucoup à : Ed Wiebe & Bill Merryfield

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 three digits immediately following the hyphen represent the theme within the session (indicated in the daily presentation listings), and the number following the decimal point indicates the placement of the poster in its theme.

For example, 2B6.1 would be the first presentation on day 2 (Tuesday), in the second "B" block of time (1030-1200), in Room 6 (Colwood).

Room ID/Identification des salles

Room/Salle 0 Lecture Theatre
Room/Salle 1 Saanich 1
Room/Salle 2 Oak Bay 1
Room/Salle 3 Oak Bay 2
Room/Salle 4 Esquimalt
Room/Salle 5 Sidney
Room/Salle 6 View Royal (Monday/lundi) Colwood (Tues-Thurs/mar-jeu)

Session Times / Temps de session

A Starts/ Commence à 08h30
B Starts/ Commence à 11h Monday/lundi ; 10h30 Tues-Thurs/mar-jeu
C Starts/ Commence à 14h Mon-Tues; 13h30 Weds-Thurs
D Starts/ Commence à 16h Mon-Tues; 15h30 Weds-Thurs
E Public Lectures/Conférences publiques 19h30-21h00 Tuesday/mardi & Thursday/jeudi, Workshops/Ateliers Wednesday/mercredi 16:30-18:00
P Poster sessions/Sessions d'affiche; Monday/lundi 16h-17h30; Weds/mercredi 15h30-17h

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 trois chiffres qui suivent le tiret indiquent le thème de la session et le chiffre indique la position de l'affiche dans le thème.

Par exemple Session 2B6.1 c'est la première présentation jour 2 (mardi), pendant le deuxième partie de temps (10h30-12), dans Salle 6 (Colwood).

Abstracts can be found on-line at / On peut retrouver les résumés en ligne, à l'adresse :
https://www1.cmos.ca/abstracts/congress_schedule.asp

WEEK-AT-A-GLANCE / APERÇU DE LA SEMAINE

CMOS 5 June 2011, Sunday

	Sooke	Langford	Oak Bay 1	Oak Bay 2	Museum
08:00 - 09:30		CMOS Publications Committee/Comité des publications SCMO 09:00 - 12:30	CNC SCOR CNC CSRO 08:00 - 13:00		
09:30 - 10:00	CMOS Students Cttee/ Comité des étudiants SCMO 09:30-12:00				
10:00 - 11:00					
11:00 - 12:00					
12:00 - 13:00	Lunch				
13:00 - 14:30		CMOS Scientific Committee/Comité scientifique SCMO	CMOS Centre Chairs/Présidents de centres SCMO	CMOS UPEC/CEPU SCMO 13:00 - 14:30	
14:30 - 16:00				CMOS Council/Conseil SCMO 14:30 - 16:00	
16:00 - 18:00				CFCAS AGM/ AGA FCSAC 16:00 - 18:00	
18:30 - 21:30					Icebreaker

WEEK-AT-A-GLANCE / APERÇU DE LA SEMAINE

CMOS 6 June 2011, Monday

	Lecture Theatre (0)	Saanich 1 (1)	Oak Bay 1 (2)	Oak Bay 2 (3)	Esquimalt (4)	Sidney (5)	View Royal (6)
08:30 - 09:00	Opening Ceremonies						
09:00 - 10:30 1A	Plenary Day 1						
10:30 - 11:00	Coffee Break – Carson Hall						
11:00 - 12:30 1B	Science in Support of Air Quality Management PART 1	Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) PART 1	Atmospheric Monitoring Networks and Operation	Modelling and analysis of atmosphere and ocean dynamic processes PART 1	Coastal Oceanography and Inland Waters PART 1	Canada's modelling contribution to the IPCC 5th assessment PART 1	Climate Change and Extreme Events PART 1
12:30 - 14:00	Lunch						
14:00 - 15:30 1C	Science in Support of Air Quality Management PART 2	Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) PART 2	Atmospheric and hydrometric monitoring: Instrumentation and Technology	Modelling and analysis of atmosphere and ocean dynamic processes PART 2	Coastal Oceanography and Inland Waters PART 2	Canada's modelling contribution to the IPCC 5th assessment PART 2	Climate Change and Extreme Events PART 2
15:30 - 16:00	Coffee Break – Carson Hall						
16:00 - 17:30 1P	Poster Session – Carson Hall						
17:30 - 18:00	CMOS AGM						

CMOS 7 June 2011, Tuesday

	Lecture Theatre (0)	Saanich 1 (1)	Oak Bay 1 (2)	Oak Bay 2 (3)	Esquimalt (4)	Sidney (5)	Colwood (6)
08:30 - 10:00 2A	Plenary Day 2						
10:00 - 10:30	Coffee Break – Carson Hall						
10:30 - 12:00 2B	Operational ice-ocean analysis and prediction PART 1	Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) PART 3	Atmospheric and hydrometric monitoring: Data Management and Service	Air Quality Health Index Forecasting and Supporting Science	Coastal Oceanography and Inland Waters PART 3	Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 1	Low-frequency variability and predictability PART 1
12:00 - 14:00	Parsons Luncheon - Crystal Garden						
14:00 - 15:30 2C	Operational ice-ocean analysis and prediction PART 2		Atmospheric and hydrometric monitoring: Space Based Monitoring	Clouds, Aerosols and Radiation PART 1	Coastal Oceanography and Inland Waters PART 4	Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 2	Low-frequency variability and predictability PART 2
15:30 - 16:00	Coffee Break – Carson Hall						
16:00 - 17:30 2D	Operational ice-ocean analysis and prediction PART 3	Weather Services	Snowfall Measurement	Clouds, Aerosols and Radiation PART 2	Ocean Processes over Topography	Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 3	Mixing in the Stratified Ocean PART 1
19:30 - 21:00 2E	Public Lecture						

WEEK-AT-A-GLANCE / APERCU DE LA SEMAINE

CMOS 8 June 2011, Wednesday

	Lecture Theatre (0)	Saanich 1 (1)	Oak Bay 1 (2)	Oak Bay 2 (3)	Esquimalt (4)	Sidney (5)	Colwood (6)
08:30 - 10:00 3A	Plenary Day 3						
10:00 - 10:30	Coffee Break – Carson Hall						
10:30 - 12:00 3B	The role of the stratosphere in weather, climate and climate change PART 1	Numerical Weather Prediction Modelling	Soil Moisture, Streamflow, and Hydrologic Impacts of Climate Change	Ocean Responses to Climate and Environmental Change PART 1	Celebrating the Scientific Career of Daniel G. Wright PART 1	Health Issues of Weather and Climate	Mixing in the Stratified Ocean PART 2
12:00 - 13:30	Lunch						
13:30 - 15:00 3C	The role of the stratosphere in weather, climate and climate change PART 2	Numerical Weather Prediction Post Processing	Application of Climate Model Results to Regional Adaptation PART 1	Ocean Responses to Climate and Environmental Change PART 2	Celebrating the Scientific Career of Daniel G. Wright PART 2	Climate and carbon cycling in northern terrestrial ecosystems	Climate prediction PART 1
15:00 - 15:30	Coffee Break – Carson Hall						
15:30 - 17:00 3P	Poster Session – Carson Hall						
16:30 - 18:00 3E		HRDPS Workshop 16:30 - 18:00		NSERC Town Hall 16:30 - 18:30	Ocean Hypoxia Town Hall 17:00 - 18:00	ECO Canada/P. Met Certification Workshop 16:30 18:00	
18:00 - 19:00	Taylor & Francis Reception – Crystal Garden						
19:00 - 21:30	CMOS Banquet – Crystal Garden						

CMOS 9 June 2011, Thursday

	Lecture Theatre (0)	Saanich 1 (1)	Oak Bay 1 (2)	Oak Bay 2 (3)	Esquimalt (4)	Sidney (5)	Colwood (6)
08:30 - 10:00 4A	Plenary Day 4						
10:00 - 10:30	Coffee Break – Carson Hall						
10:30 - 12:00 4B	Climate change and the carbon cycle PART 1	New Avenues in Forecast Verification	Application of Climate Model Results to Regional Adaptation PART 2	Atmosphere, Ocean, and Climate Dynamics PART 1	Celebrating the Scientific Career of Daniel G. Wright PART 3	Acoustics in Oceanography	Climate prediction PART 2
12:00 - 13:30	Lunch					Ocean Science Coalition Town Hall Meeting (4X)	
13:30 - 15:00 4C	Climate change and the carbon cycle PART 2	George Boer Session on Climate Modelling and Analysis PART 1	Validation of empirical-statistical downscaling methods in a varying climate system PART 1	Atmosphere, Ocean, and Climate Dynamics PART 2	Remote Sensing & Oceans	Physical-Biological Interactions in Aquatic Environments PART 1	Renewable Energy - The Important Role of Meteorological and Oceanographic Sciences PART 1
15:00 - 15:30	Coffee Break – Carson Hall						
15:30 - 17:00 4D	Climate change and the carbon cycle PART 3	George Boer Session on Climate Modelling and Analysis PART 2	Validation of empirical-statistical downscaling methods in a varying climate system PART 2	General Atmospheric Science	Remote Sensing of the Ocean Surface - Synthetic Aperture Radar	Physical-Biological Interactions in Aquatic Environments PART 2	Renewable Energy - The Important Role of Meteorological and Oceanographic Sciences PART 2
19:30 - 21:00	Public Lecture						

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011						
08:20 The Weather Network/Météomédia weather briefing / 08:30 Opening Ceremonies						
Plenary Day 1/Plénière Jour 1 Lecture Theatre	09:00: Uncertainty in climate change projections: the role of natural variability; *Clara Deser* 09:45: Satellite remote sensing of global air pollution; *Randall Martin*					Session 1A
						Session 1B
Session	1 11:00	2 11:15	3 11:30	4 11:45	5 12:00	6 12:15
Science in Support of Air Quality Management - PART 1 Lecture Theatre	An Improved Approach to Air Quality Forecasting: Implications for Municipal Planning and Public Health Promotion *Qiu, Xin*		Spatiotemporal source apportionment of policy-relevant metrics *Hakami, Amir*		The use of image metric techniques to track changes in visibility *Teakles, Andrew*	Improved Accuracy in Measuring Global Distribution, Circulation and Sequestration of Greenhouse Gases Utilizing Top-Down and Inverse Modeling Approaches *Anderson, James*
Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) -PART 1 Saanich 1	Science and Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) – Overview of results to date *Isaac, G.A.*		Uncertainty in measurements collected at the RND site the during SNOW-V10 Project *Gultepe, Ismail*	Nowcasting for SNOW-V10 using Adaptive Blending of Observations and Model Data *Bailey, Monika*	Observation of Precipitation and Precipitation Type During the 2010 Winter Olympics in Vancouver and Its Impact on Visibility *Boudala, Faisal*	Gravity wave reflection and its associated triggering of locally heavy precipitation during SNOW-V10 *Brugman, Melinda*
Atmospheric Monitoring Networks and Operations Oak Bay 1	How do we maintain sustainable high-quality climate observation networks that can answer the question: How has the climate changed over the past 50 years? *Baker, Bruce*	British Columbia's Climate Related Monitoring Program – A Status Report *Weick, E. (Ted) J.*	Designing the Foundations for Understanding the Past and Predicting the Future - The Meteorological Service of Canada's Network Planning and Design Process *Zucconi, Alexander*	The Canadian AMDAR Program – An Updated Strategy for the Decade 2011-2020 *Fournier, Gilles*	Eureka Weather Station Operational Logistics *Wowryk, Ken*	Meteorological Training Of New Atmospheric Monitoring Network Technicians *Clifford, Keith*
Modelling and analysis of atmosphere and ocean dynamic processes PART 1 Oak Bay 2	Modeling North Pacific Decadal Variations and Their Teleconnection Patterns *Feng, Pei-Ning*	Effects of variations in solar activity on modes of low-frequency circulation variability in the Pacific / North American extratropics *Huth, Radan*	Contribution of the autumn Tibetan Plateau snow cover to seasonal prediction of North American winter temperature *Lin, Hai*	Recent Improvements in Scatterometer Wind Vector Data Assimilation at Environment Canada *Reszka, Mateusz*	Interactive Lakes in the Canadian Regional Climate Model, version 5: the Role of Lakes in the Regional Climate of North America *Martynov, Andrey*	Changes of wave heights in North Atlantic Ocean under the IPCCAR4 scenario A1B *Guo, Lanli*

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011						Session 1B
Session	1 11:00	2 11:15	3 11:30	4 11:45	5 12:00	6 12:15
Coastal Oceanography and Inland Waters PART 1 Esquimalt	Development of a coupled ice-ocean modelling system for Hamilton Inlet (Newfoundland and Labrador). *Chassé, Joël*	Hydrographic and circulation study in Hermitage Bay/Bay d'Espoir, Newfoundland *Ratsimandresy, Andry William*	Application of a Multi-Nested Ocean Circulation Model for Investigating Circulation, Flushing Time and Dispersion in Halifax Harbour and Adjacent Waters *Shan, Shiliang*	Double-diffusive instabilities in the relic seawater of meromictic Powell Lake, B.C.? *Pawlowicz, Rich*	A Rogue Wave Event at Middle Cove Beach, Newfoundland *Telford, Devon*	A super-regional test-bed to improve wave models *Toulany, Bechara*
Canada's modelling contribution to the IPCC 5th assessment PART 1 Sidney	The IPCC 5th Assessment Report *Zwiers, Francis*		The Second Generation Canadian Earth System Model (CanESM2): An Overview *Flato, Gregory*		The Amazonian Region: Hot spot of positive carbon-climate feedback in CanESM2 AR5 simulations *Arora, Vivek*	Ocean biogeochemistry in the enhanced greenhouse: the ocean carbon cycle in simulations with the Canadian Earth System Model *Christian, James*
Climate Change and Extreme Events PART 1 View Royal	Projections of climate change extremes in British Columbia *Murdock, Trevor*	Extreme cold winter temperatures in Europe under the influence of atmospheric blocking *Sillmann, Jana*	Application of Statistical Downscaling Model (SDSM) on Simulation of Precipitation during Hurricane Season in Toronto, Canada *Jien, Jerry*	Characterisation of storms in Nunavik coastal regions for assessment of the vulnerability of coastal infrastructures to climate change *Savard, Jean-Pierre*	Occurrence of deep convective events under a changing climate using CRCM simulations. *Paquin, Dominique*	

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011						Session 1C
Session	1 14:00	2 14:15	3 14:30	4 14:45	5 15:00	6 15:15
Science in Support of Air Quality Management PART 2 Lecture Theatre	Investigation of size-resolved parameterizations for below-cloud particle scavenging *Zhang, Leiming*		The Border Air Quality and Meteorology Study (BAQS-Met): Overview, Comparisons between Observations and Models, and Lessons Learned *Makar, Paul*	The influence of Synoptic Weather Conditions on Weekday-Weekend Effect of Extreme Ground-level Ozone Events in the Toronto area, Canada *Leung, Kinson*	Spatial and temporal comparisons of CMAQ and AURAMS modelling runs at 12-km resolution over coastal BC *Nissen, Robert*	Creating Actionable Air Quality Data using RDF (Resource Description Framework) *Freemantle, James*
Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) - PART 2 Saanich 1	Observations of Microphysical Processes at the Vancouver 2010 Winter Olympic Games *Joe, Paul*		Thermodynamic and Liquid Profiling at the Alpine Venue of the 2010 Winter Games *Ware, Randolph 'Stick'*	A case study of diabatic cooling of melting snow during the 2010 Vancouver Olympics *Theriault, Julie*	Heavy Snowfall Occurred as Ozone Wrapped Beneath Warm Moist Conveyors during Snow-V10 *Brugman, Mindy*	Snow particle spectra from FMD, GCIP, SVI, and distrometers measurements collected at the RND site during SNOW-V10 Project *Gultepe, Ismail*
Atmospheric and hydrometric monitoring: Instrumentation and Technology Oak Bay 1	Complications Regarding Automated Snowfall Measurements—2010 Winter Olympics *Scott, Bill*	Development of a next generation moored buoy system *Marshall, Chris*	A New Modern Tropospheric Radar Wind Profiler for Research and National Networks *McLaughlin, Scott*	CARS-CAP Automated Weather Reporting *Davies, Peter*	Radio-Frequencies Used by National Meteorological and Hydrological Services (NMHS)– An Overview of Current and Future Threats and Opportunities *Fournier, Gilles*	One Good Measurement is worth a Thousand Expert Opinions: The Role of Metrology in Meteorology. *Hampel, Christopher*
Modelling and analysis of atmosphere and ocean dynamic processes PART 2 Oak Bay 2	Simulation of seasonal and decadal-scale variability in the Caspian Sea *Budgell, Paul*	Spatiotemporally variable coastal upwelling circulation in northeastern South China Sea *Gan, Jianping*	Modelling the seasonal and inter-annual variations of water transport and sea-ice in the Canadian Arctic Archipelago *Nudds, Shannon*	Impacts of Canada Basin Freshwater Content on the Pacific Water Inflow Routes within the Arctic Ocean *Hu, Xianmin*	High-resolution basin-scale ocean modelling and analysis *Lu, Youyu*	

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011 — **Session 1C**

Session	1 14:00	2 14:15	3 14:30	4 14:45	5 15:00	6 15:15
Coastal Oceanography and Inland Waters PART 2 **Esquimalt**	Simulation of three-dimensional circulation and hydrography over the Grand Banks of Newfoundland *Han, Guoqi*	Observations and modelling of hydrodynamics and water quality in Lake Winnipeg *Yerubandi, Ram Rao*	Rigorous inter-comparison of three hydrodynamic models for Lakes Erie and Ontario *Dupont, Frederic*	Validation of new environment Canada winds on search and rescue drift calculations *Wells, Jennifer*	Euphotic zone nitrate regeneration in a highly productive NE Pacific fjord: Implications for measurements of coastal new production *Grundle, Damian*	Using polynomial chaos to uncover time dependence of optimal parameter values in a biological ocean model *Mattern, Jann Paul*
Canada's modelling contribution to the IPCC 5th assessment PART 2 **Sidney**	CanRCM4: A New Regional Climate Model for Downscaling Canada's CMIP5 Contribution *Scinocca, John*		Ocean climate, variability and change on CanESM2 *Merryfield, William*	Modelled Precipitation Changes Under a Simple Geoengineering Scheme *Shumlich, Michael*	The ratio of land to ocean temperature change under global warming *Boer, George*	Observationally-constrained projections of 21st century changes in temperature and precipitation *Gillett, Nathan*
Climate Change and Extreme Events PART 2 **View Royal**	Extreme events and natural disturbances in northern British Columbia *Foord, Vanessa*	Ontario Ministry of Transportation (MTO) phase 2 progress *Soulis, Ric*	Diminished windstorm frequency in southwest British Columbia and a possible association with the Pacific Decadal Oscillation regime shift of 1976-77: Using atmospheric pressure as a proxy to support observed trends in extreme winds *Read, Wolf*	Possible Impacts of Climate Change on Snowfall and Snow Depth over Northern Canada under Downscaled Future Climate Conditions *Cheng, Chad Shouquan*		

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011							Session 1P
POSTER **Clouds, Aerosols and Radiation** **(201)** **Carson Hall**	Comparison of cloud properties and precipitation between observations, reanalyses, and models. *Corbel, Christophe*	Observations of aerosol effects on the microphysics and radiative properties of Arctic liquid-phase clouds *Earle, Michael*	Improved Wintertime Measurements with the CANDAC Rayleigh-Mie-Raman Lidar at Eureka, Nunavut *Perro, Christopher*	Volcanic perturbations to the stratospheric aerosol layer in the last decade *Bourassa, Adam*			
POSTER **Science in Support of Air Quality Management** **(205)** **Carson Hall**	Modeling dry deposition and resuspension of aerosols in atmospheric dispersion models *Feng, Jian*	A climatology for surface ozone and PM2.5 for North America using objective analysis techniques. *Robichaud, Alain*	Statistical comparison of CMAQ and AURAMS modelling runs at 12-km resolution over coastal BC *Nissen, Robert*	A cluster analysis of back trajectories to evaluate transport of PM2.5 in southern Quebec *Lehr, Pamela*	Production and Transport of Ozone From Boreal Forest Fires *Liu, Jane*	A Stratospheric Ozone Climatology From Global Ozone Soundings and Trajectory Statistics *Liu, Jane*	Transport Analysis of Ozone Enhancement in Southern Ontario during BAQS-Met *HE, HUIXIA*
POSTER **Ocean Processes over Topography** **(301)** **Carson Hall**	Internal tide generation in the presence of background currents *Dunphy, Michael*	Resonant amplification of sub-inertial tides in a submarine canyon *Swart, Neil*	Estimating the exchange flow through a canyon; a scaling analysis *Allen, Susan*	Power of Realtime, Continuous, Remote Observations in Capturing Patchy Episodic Fluid-Substrate Events in the Marine Realm: Examples from the NEPTUNE Canada Ocean Network. *Best, Mairi*			
POSTER **Coastal Oceanography and Inland Waters** **(306)** **Carson Hall**	Coastal water column observations using the NEPTUNE Canada Ocean Network: Recent developments *Mihaly, Steven*	Storm surge forecasting for coastal British Columbia *Tinis, Scott*	Spatial wind patterns and their impacts on drift in Newfoundland bays *Han, Guoqi*	Modelling the continental shelf of Atlantic Canada *Bianucci, Laura*	Testing the Performance of Coastal Ocean Observational Systems with Ensemble Methods *De Mey, Pierre*	Coloured Dissolved Organic Matter in the Strait of Georgia: Seasonality and relationships with freshwater discharge *Wright, Cynthia*	A high-resolution sediment trap study of organic-walled dinoflagellate cyst production and biogenic silica flux in Saanich Inlet (BC, Canada) *Price, Andrea*

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011							Session 1P
POSTER General Oceanographic Science (308) Carson Hall	Biologically-induced changes in subarctic Pacific surface waters determined from underway dissolved oxygen and nitrogen measurements, 2007 and 2008 *Benoit, Philippe*	Model simulated variations of meso-scale eddy activity near the Tail of the Grand Banks *Lin, Yuehua*	Hydrographic and Circulation Variability in the Orphan Basin Region during the Past Decade *Loder, John*	Applications of west coast wave buoy data *Gemmrich, Johannes*	A Hindcast Experiment for the Kuroshio-Oyashio region based on Regional Ocean Modeling System (ROMS) *Kuroda, Hiroshi*	Physical, chemical and biological oceanographic variability in the Labrador Sea during 2000-2009 *Greenan, Blair*	Meteorological and Oceanographic Support to the Canadian Navy in the North-East Pacific *Suesser, Ulrich*
POSTER Climate Change and Extreme Events (403) Carson Hall	Projected changes to multi-day precipitation extremes over Quebec watersheds using a multi-RCM ensemble *Monette, André*	Canadian RCM projected changes to extreme flows in Quebec watersheds *Clavet-Gaumont, Jacinthe*	Hydrological extremes in the Fraser River Basin *Dery, Stephen*				
POSTER Low-frequency variability and predictability (406) Carson Hall	The Influence of Solar Variability on the Atmosphere and Ocean Dynamics *Chueh, Pei-Yu*	Examination of Historical Climatic Drivers of Streamflow Generation in the Athabasca River Watershed: A Focus on Precipitation and Climate Oscillations *Peters, Daniel*	The influence of the sea surface temperature on the interannual variability and potential predictability of the mean seasonal atmospheric conditions *Viktor, Elisabeth*				
POSTER Modelling and analysis of atmosphere and ocean dynamic processes. (502) Carson Hall	Parallel domain-decomposed Eddy-Resolving model Taiwan Multi- scale Community Ocean Model *Chien, Mu-hua*	The Role of Resolution in Modelling Fluxes Through the Canadian Arctic Archipelago *Myers, Paul*	Energy Balance at the Air-Sea Interface of the Tropical Atlantic Ocean *Dutra, Livia*				

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011							Session 1P
POSTER **Operational ice-ocean analysis and prediction** **(504)** **Carson Hall**	Assimilation of AVHRR data in an automated sea ice analysis system *Buehner, Mark*	Development of a Modelling Capacity for the Canadian Arctic Archipelago *Myers, Paul*	Flow Pathways through the Canadian Arctic Archipelago *Wang, Qiang*				
POSTER **Atmospheric Monitoring Networks and Operations** **(602)** **Carson Hall**	Networking for a Network of Networks *Zucconi, Alex*	British Columbia Forest Science Climate-Hydromet Research Network *Foord, Vanessa*	The Canadian Precipitation Analysis (CaPA): Near real-time precipitation mapping in poorly gauged northern latitudes using optimal interpolation and considering solid precipitation measurement issues *Deacu, Daniel*	The role of Prairie and Northern in the installation and maintenance of Environment Canada's Atmospheric Monitoring Networks *Gresiuk, Ted*	The End of Storm Chasing? Detection Probabilities for Spatially Dense Networks From First-Order Nearest-Neighbour Distributions For Network Design. *Hampel, Christopher*		
POSTER **Snowfall Measurement** **(605)** **Carson Hall**	Overview of Snowflake Observations from Two Locations using the Snowflake Video Imager (SVI) *Kucera, Paul*						
POSTER **Atmospheric and hydrometric monitoring: Data Management and Services** **(607)** **Carson Hall**	The Monitoring of Surface Ozone and PM2.5 Observations at the Canadian Meteorological Center. *Zaitseva, Yulia*						

SCHEDULES / HORAIRE DES SESSIONS

Monday, 6 June 2011/Lundi, 6 juin 2011							Session 1P
POSTER **Air Quality Health Index Forecasting and Supporting Science** **(705)** **Carson Hall**	Technical Challenges of the XM Tool Project: A Comparison of Statistical Post-Processing Methods in Support of the Canadian Air Quality Health Index Forecast Program *Perry, Sean*	A Study of the Impacts of Local Emissions on the AQHI in Pictou, Nova Scotia *Jubainville, Daniel*	Data transfer and data processing for the national AQHI forecast program *Anselmo, David*				

SCHEDULES / HORAIRE DES SESSIONS

Tuesday, 7 June 2011/Mardi, 7 juin 2011

08:20 The Weather Network/Météomédia weather briefing

Plenary Day 2/Plénière jour 2 **Lecture Theatre**	08:30: The science of "ocean dead zones" and the changing Pacific; *Peter Brewer* 09:15: Adapting to 21st century shoreline change on the Pacific coast; *Philip Mote (Sponsored by Pacific Climate Imacts Consortium)*	**Session 2A**

Session 2B

Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
Operational Ice-ocean analysis and prediction PART 1 **Lecture Theatre**	The METAREA Initiative – A Governmental Focus on the Arctic *Gauthier, Marie-France*	Towards an integrated marine Arctic prediction system for METAREAs *Ritchie, C. Harold*	An Operational Automated Sea Ice Analysis System *Carrieres, Thomas*	Assimilation of ASCAT data in an automated sea ice analysis system *Buehner, Mark*	Development of a new global sea ice analysis at the Meteorological Service of Canada. *Caya, Alain*	Assessing an Ensemble Optimal Interpolation data assimilation scheme applied to the North Atlantic Ocean *Korabel, Vasily*
Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) PART 3 **Saanich 1**	The high-resolution numerical weather prediction system for the 2010 Vancouver Olympics *Mailhot, Jocelyn*		Integrating NWP Forecasts and Observation Data for Nowcasting over Complex Terrain *Huang, Laura*	Evaluation and operational support by the National Laboratory of the Atlantic during the Canada Winter Games in 2011 *Desjardins, Serge*	Reanalysis of a band of heavy rain and strong wind across the Inner South Coast of British Columbia *Mo, Ruping*	Observation and prediction of Wind Gust During the 2010 Winter Olympics in Vancouver : Model comparisons *Boudala, Faisal*
Atmospheric and hydrometric monitoring: Data Management and Services **Oak Bay 1**	Meteorological Service of Canada's Data Management Initiative *Colavecchia, Tony*	Simplifying Data Requirements for Mean Sea-Level Pressure Calculations in Canada: Reducing Inherent Risks in Current Approaches to The Plateau Correction. *Hampel, Christopher*	Achieving known and identified quality for all Meteorological Service of Canada data by enhancing quality assessment within a new Data Quality Management System *Fong, Hannah*	Data Services from the Meteorological Service of Canada *Allen, Shannon*	CODECON retirement and its resultant improvement of atmospheric data from MSC automatic monitoring sites. *MacPhee, John*	
Air Quality Health Index Forecasting and Supporting Science **Oak Bay 2**	Advances in Applying Satellite Remote Sensing to the AQHI *Martin, Randall*	Improving AQHI forecasting by quantifying the spatial and temporal variation of PM2.5, NO2 and ground-level O3 in urban Halifax and rural Annapolis Valley, Nova Scotia, Canada *King, Gavin*	Assessing the possibility of AQHI forecasting using GEM-MACH15 prediction tendency *Li, Qian*	The XM Tool Prototype: A new statistical post-processing tool available in Canada to support of the Air Quality Health Index (AQHI) forecast program *Teakles, Andrew*	Air quality forecasting by neural networks and support vector regression based on feature selection by mutual information *Jenkner, Johannes*	Data transfer and data processing for the national AQHI forecast program *Anselmo, David*

SCHEDULES / HORAIRE DES SESSIONS

Tuesday, 7 June 2011/Mardi, 7 juin 2011						Session 2B
Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
Coastal Oceanography and Inland Waters PART 3 Esquimalt	Climate change, mean sea level and high tides in the Bay of Fundy *Greenberg, David*	Modeled Patterns of Regional Sea Level Rise around Taiwan *Young, Chih-Chieh*	Investigating far-field effects of tidal in-stream energy extraction in the Minas Passage on tidal circulation in the Bay of Fundy and the Gulf of Maine using a nested-grid coastal ocean circulation model *Sheng, Jinyu*	A Circulation Model for the Discovery Islands, British Columbia *Foreman, Michael*	Seasonal variations of tides in shallow waters *Mueller, Malte*	
Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 1 Sidney	Recent changes in water masses of the southern California Current *Bograd, Steven*		A region of increasing hypoxia on the British Columbia Shelf *Crawford, Bill*	A year of benthic community responses to fluctuating oxygen levels assessed through online observations *Matabos, Marjolaine*	Seasonal dynamics of microbial mat growth at the VENUS observatory in Saanich Inlet, British Columbia *Juniper, Kim*	Nitrate isotope fractionation druing denitrification in Saanich Inlet: water column versus sediment effects *Bourbonnais, Annie*
Low-frequency variability and predictability PART 1 Colwood	The atmospheric response to moving tropical heat sources *Branstator, Grant*		Forecast skill of Madden-Julian oscillation in CCCma coupled ocean-atmospheric models *Ravindran, Ajayamohan*	Modification of an MJO Index and its Applications *Anderson, Thomas*	The Madden-Julian Oscillation: A 100-year reconstruction and a discussion of predictability based on a stochastically forced damped oscillator model *Oliver, Eric*	Impact of the Madden-Julian Oscillation on the intraseasonal forecast skill of the North Atlantic Oscillation *Lin, Hai*

SCHEDULES / HORAIRE DES SESSIONS

Tuesday, 7 June 2011/Mardi, 7 juin 2011						Session 2C
Session	**1** **14:00**	**2** **14:15**	**3** **14:30**	**4** **14:45**	**5** **15:00**	**6** **15:15**
Operational ice-ocean analysis and prediction PART 2 **Lecture Theatre**	Operational Oceanography – A Renewed Focus within Fisheries and Oceans Canada *Joseph, Helen*	Evaluation of SST Analyses and Forecasts with the CONCEPTS Global Coupled Prediction System *Roy, Francois*	Spectral Nudging for Improving Global Coupled Atmosphere-Ocean Model Forecasts *He, Zhongjie*	Complementing DFO's monitoring programs with an operational ocean forecast and reanalysis system as part of CONCEPTS. *Cooke, Melanie*	A model sensitivity study of the space-time evolution of the sea ice distribution in the northwest Atlantic *Hannah, Charles*	Validation protocols for the CONCEPTS Regional and Global Ocean Forecast Systems *Davidson, Fraser*
Atmospheric and hydrometric monitoring: Space-Based Monitoring **Oak Bay 1**	Status of the Polar Communications and Weather (PCW) mission *Garand, Louis*		Addressing the challenge of measuring continental precipitation *Cober, Stewart*	Canadian Snow Cover Mapping Through Assimilation of Satellite Radiances and CMC Snow Depth Analysis *Fernandes, Richard*	Validation of GOES retrieval algorithms for the detection of fog, visibility and icing conditions *Gultepe, Ismail*	
Clouds, Aerosols and Radiation PART 1 **Oak Bay 2**	An algorithm for constructing 3D cloud fields from profiles retrieved from active-passive satellite data *Barker, Howard*	Validation Prospects of Aerosols Properties for the Future GCOM-C/SGLI Satellite *Dim, Jules R.*	A quasi-geostationary view of the Arctic and environs: PCW/PHEMOS for Arctic weather, climate and air quality *O'Neill, Norm*	Comparison of UV-B broadband Brewer measurements with irradiances from surface-based and satellite-based models *Binyamin, Jacqueline*	Longwave radiation observations, modeling and reconstruction in the winter High Arctic. *Pike-Thackray, Colin*	Seasonal controls on urban-rural differences of the surface radiation budget *Christen, Andreas*
Coastal Oceanography and Inland Waters PART 4 **Esquimalt**	A tsunami generated by a Cascadia subduction zone event, coastal British Columbia. *Walters, Roy*	Modeling estuarine circulation and sediment transport induced by subglacial freshwater discharges in glacial fjords *Salcedo-Castro, Julio*	3D Numerical Modeling of Flows and Sediment Transport for Tidal Current Turbines in Canoe Pass, British Columbia *Jiang, Jianhua*	Inferring sediment transport pattern in the Bay of Fundy from tidal velocity fields *Wu, Yongsheng*	Comparative assessment of a two-layered and a multi-layered sediment model. *Wilson, Robin*	
Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 2 **Sidney**	Overview of the synthesis papers produced by SCOR working group 128 on coastal hypoxia (2005-2010) *Gilbert, Denis*		Dissolved oxygen sensitivity to environmental changes in the Estuary and Gulf of St. Lawrence *Nicot, Paul*	Impact Of Persistently Low Oxygen Levels In Bottom-Waters On Sediment Chemistry: The Case Of The Lower St. Lawrence Estuary *Sundby, Bjorn*	Estimating marine nutrient loss from dissolved N_2/Ar measurements *Hamme, Roberta*	Variation in the concentration of redox sensitive dissolved metals in response to a bottom water renewal event in Saanich Inlet, BC *Cullen, Jay*

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Tuesday, 7 June 2011/Mardi, 7 juin 2011						Session 2C
Session	1 14:00	2 14:15	3 14:30	4 14:45	5 15:00	6 15:15
Low-frequency variability and predictability PART 2 Colwood	Simulation of the Northern Hemisphere "Cold-Low" Event Climatology Using a Coupled Climate Model *Lambert, Steven*	Evaluation of monthly forecasts of intense winter storms from global forecast models. *Rabin, Robert*	Why can't climate models capture the observed connection between seasonal snow cover and the Northern Annular Mode? *Smith, Karen*	Analysis of Precipitation and 2m Temperature from the NARCCAP regional Climate Projection Ensemble. *Biner, Sébastien*		

Tuesday, 7 June 2011/Mardi, 7 juin 2011						Session 2D
Session	1 16:00	2 16:15	3 16:30	4 16:45	5 17:00	6 17:15
Operational ice-ocean analysis and prediction PART 3 Lecture Theatre	The Response of Sea Ice Drift to Wind and Current Forcing in the Canadian Beaufort Sea *Borg, Keath*	Modeling wave-ice interactions *Dumont, Dany*	Long-Range Ice Forecast System at CIS – An Operational Method *Desjardins, Luc*	Canadian Ice Service (CIS) Update of 30-Year Climatological Sea Ice Atlases (1981-2010) *McCourt, Steve*	Long-Term Trends in the Physical Environment along the Northwest Passage Shipping Route *Martinez de Saavedra Álvarez, Mar*	A SAR Feature Database for Sea Ice Data Assimilation *Pogson, Lynn*
Weather services Saanich 1	Progress and future directions of the Canadian weather and environmental prediction and services systems : optimizing research to operations mechanisms. *Wartman, Dave*		A service strategy for the Meteorological Service of Canada *St-Coeur, Joanne*	Communicating Weather with External Clients *Jones, David*	Alerting Canadians of significant weather events with the help of the Common Alerting Protocol (CAP) *St-Coeur, Joanne*	Support to Environmental Emergencies at the Meteorological Service of Canada *Bois, Nicole*
Snowfall Measurement Oak Bay 1	WMO intercomparison of instruments and configurations for measuring solid preciptiation *Nitu, Rodica*	The NOAA/FAA/NCAR Winter Precipitation Test Bed: How Well Are We Measuring Snow? *Rasmussen, Roy*	Using sonic anemometers for design and testing of wind shields *Meyers, Tilden*	Precipitation Gauge Performance During High-Wind/High-Rate Snowfall Events *Landolt, Scott*	Windshield efficacy at the NOAA/FAA/NCAR winter precipitation testbed *Kochendorfer, John*	Relationship between snow gauge collection efficiency and snowflake type *Theriault, Julie*
Clouds, Aerosols and Radiation PART 2 Oak Bay 2	Overlap of Solar and Infrared Spectra and its Climate Impact *Li, Jiangnan*	Statistical analysis of an LES trade-cumulus cloud field *Dawe, Jordan*	Hindcast of clouds, precipitation and climate with CanAM4 *von Salzen, Knut*	Parameterization of Dust Aerosol Optical Properties and Radiative Forcing in CanAM4-PAM *Peng, Yiran*	Climate Change, Anthropogenic Aerosols, and Impacts on Human Health. *Makar, Paul A.*	Parameterizations of Relative Humidity and Cirrus Cloud Formation from CloudSat and ACE for GCM Model Comparisons *Evans, Wayne*

SCHEDULES / HORAIRE DES SESSIONS

Tuesday, 7 June 2011/Mardi, 7 juin 2011						Session 2D
Session	**1 16:00**	**2 16:15**	**3 16:30**	**4 16:45**	**5 17:00**	**6 17:15**
Ocean Processes over Topography Esquimalt	The Role of Submarine Canyons and Banks in Nutrient Supply to the Canadian/US Western Coastal Ocean *Hickey, Barbara*		Observations of circulation and tides in the Sable Gully *Greenan, Blair*	Seasonal flow variability in the straits connecting Prince William Sound to the Gulf of Alaska *Halverson, Mark*	Observations of long-duration episodic bottom currents in the Middle America Trench: Evidence for tidally initiated turbidity flows *Thomson, R.E.*	Energetics of Internal Solitary Waves in a Background Sheared Current: the Important role of Topography and a Free Surface *Lamb, Kevin*
Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses PART 3 Sidney	Some consequences of declining oxygen in the Subarctic Pacific *Whitney, Frank*		Nitrous oxide production in the sub-oxic waters of the NE Pacific *Grundle, Damian*	Bacterial community structure and dynamics in the oxygen minimum zone of the northeast subarctic Pacific Ocean *Wright, Jody*	Effect of sedimentary denitrification on near-bottom oxygen concentrations *Bianucci, Laura*	Thriving in an oxygen minimum zone: proteomic analysis of SUP05 energy metabolism *Hawley, Alyse*
Mixing in the Stratified Ocean PART 1 Colwood	Tracer-Contour Inversion: pathway to global mixing fields? *McDougall, Trevor*		Turbulent Collapse in Stratified Free Shear Layers: The Role of Secondary Instability *Mashayek, Ali*	High-order balance in rotating stratified turbulence *Bartello, Peter*	Vertical propagating internal waves generated by a sheared turbulent layer *Munroe, James*	What controls the erosion of the cold intermediate layer in the Gulf of St. Lawrence? *Cyr, Frédéric*

Tuesday, 7 June 2011/Mardi, 7 juin 2011	Session 2E
Plenary Public Lecture/Plénière Conférence Publique – Lecture Theatre	19:30: The North Pacific – An Ocean in Transition: *Ken Denman*

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011

08:20 The Weather Network/Météomédia weather briefing

Plenary Day 3/Plénière jour 3 **Lecture Theatre**	08:30: Modelling fish response to climate forcing; *Shin-ichi Ito (Sponsored by PICES)* 09:15: The impact of increasing greenhouse gases on El Nino/Southern Oscillation (ENSO); *David Battisti*	**Session 3A**

Session 3B

Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
The role of the stratosphere in weather, climate and climate change PART 1 **Lecture Theatre**	The coupled stratosphere-troposphere response to climate change *Shepherd, Theodore*		Impacts of stratospheric ozone depletion on the Southern Ocean and Antarctic sea-ice *Fyfe, John*	Toward understanding the dynamics of stratosphere-troposphere coupling *Thompson, David*		The Influence of a Well-Resolved Stratosphere on Seasonal Prediction *Scinocca, John*
Numerical Weather Prediction : Modelling **Saanich 1**	An update from CMC Operations *Bois, Nicole*	A Major Upgrade to the Canadian Global Deterministic Forecast System *Heilliette, Sylvain*	Towards an operational Canadian regional ensemble prediction system. *Charron, Martin*	An Evaluation of the GEM-REG Model Predictions for Hurricane Igor *Braet, Damian*	HPC at the Canadian Meteorological Centre *Denis, Bertrand*	Using graphical processing units to speed up numerical weather prediction *Nipen, Thomas*
Soil Moisture, Streamflow, and Hydrologic Impacts of Climate Change **Oak Bay 1**	Crop evapotranspiration impacts on drought and convective environments *Strong, G.S.*		Climate change impacts in the British Columbia watersheds: Comparison of GCM-downscaled and hydrologic model simulated outputs with RCM outputs *Shrestha, Rajesh*	Analysis and Inter-Comparison of Multiple RCM based Hydro-Climate Scenarios in the Lake Winnipeg Watershed *Dibike, Yonas*	Closing the hydrologic cycle for climate simulations using a simple yet rigorous approximation of Richard's Equation applied to the soil-water balance *Soulis, Ric*	Affect of climate changes on long-term river flow fluctuations *Frolov, Anatoly*
Ocean Responses to Climate and Environmental Change PART 1 **Oak Bay 2**	Risk-Based Climate Change Science in Canada's Three Oceans *Lyon, Paul*	Early steps in the establishment of a global oxygen observing system prompted by climate change scenarios of ocean deoxygenation. *Gilbert, Denis*	Determination of acidification state of the Canadian Pacific coastal waters using empirical relationships with hydrographic data *Lara-Espinosa, Alejandra*	Kinetics of superoxide decay in eastern subarctic Pacific waters *Schallenberg, Christina*	Development of transfer functions for paleoceanographical reconstructions in the North Pacific Ocean, based on dinocyst assemblages *Bonnet, Sophie*	Trends in Upwelling and Downwelling Winds along the British Columbia Shelf *Foreman, Michael*

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011						Session 3B
Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
Celebrating the Scientific Career of Daniel G. Wright PART 1 **Esquimalt**	Dan Wright's key contributions to the development of ocean climate models of intermediate complexity *Stocker, Thomas*		Integrating Observational, Theoretical and Numerical Modelling Approaches in Deep Ocean Studies: An Overview with Emphasis on the Contributions of Daniel G. Wright *Lu, Youyu*		Impact of the model bias on water mass properties and circulation in eddy-permitting simulations of the subpolar North Atlantic *Demirov, Entcho*	Spectral nudging and deep Labrador Sea convection events *Dupont, Frederic*
Health Issues of Weather and Climate **Sidney**	Schoolyard and Public Space Heat Islands: A Study in Windsor-Essex, Sarnia-Lambton and Chatham-Kent, Ontario *Moogk-Soulis, Carol*	Modelling spatial variations in energy budgets of humans exercising in outdoor urban recreational parks and spaces *Vanos, Jenni*	Climate Connections to Insects and Diseases in the Canadian Prairies *Wittrock, Virginia*	Trends and Variability in the Start of the Outdoor Skating Season in Canada *Damyanov, Nikolay*	The 2009 and 2010 forest fires in British Columbia posed a health threat to people most at risk from air pollution – and created a "teachable moment" *Stevens, Sharon*	
Mixing in the Stratified Ocean PART 2 **Colwood**	A classification of stratified shear flow instabilities and implications for mixing in geophysical flows *Carpenter, Jeff*	Ejection mechanism in Holmboe waves *Guha, Anirban*	Laboratory investigation of three modes of instability in a stratified shear flow *Tedford, Edmund*	The effect of Reynolds number on mixing in Kelvin-Helmholtz instability *Rahmani, Mona*	Three-dimensional Simulations of Shear Instabilities in Internal Solitary Waves *Lamb, Kevin*	

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011						Session 3C
Session	1 13:30	2 13:45	3 14:00	4 14:15	5 14:30	6 14:45
The role of the stratosphere in weather, climate and climate change PART 2 **Lecture Theatre**	Is the Brewer-Dobson Circulation Driven by Tropospheric Baroclinic Waves or by Upper Stratospheric Planetary Waves? *Wallace, John*		Geographical dependence of blocking high contributions to the stratospheric variability through enhancement and suppression of upward planetary-wave propagation *Orsolini, Yvan*	Dynamics of the lower stratospheric circulation response to ENSO. *Simpson, Isla*	Tropospheric and Stratospheric Ozone Changes in the Canadian Middle Atmosphere Model (CMAM) with Tropospheric Chemistry *Reader, Mary Catherine*	An Objective Definition of the Tropopause *Erler, Andre*
Numerical Weather Prediction : Post Processing **Saanich 1**	Scribe Nowcasting: Understanding the System *Talbot, Donald*	Scribe Nowcasting: Towards Improved Performances *Landry, Claude*	Gene-expression programming — a way to improve precipitation forecasts in mountainous W. Canada *Bakhshaii, Atoossa*	Using Total Lightning Data in Severe Storm Prediction: Case Studies from the North *Liu, Chonglin*	Automated Fog and Stratus Forecasts From the CMC RDPS Operational Model *Burrows, William*	Updating probabilistic weather forecasts using recent observations *Nipen, Thomas*
Application of Climate Model Results to Regional Adaptation PART 1 **Oak Bay 1**	Informing Adaptive Responses to Climate Change in the Prairie Provinces *Sauchyn, Dave*		Hydrologic impacts of climate change in select watersheds of British Columbia, Canada *Schnorbus, Markus*	Identifying an empirical downscaling strategy for Ouranos: A balance between reliability and flexibility *Huard, David*	Future projections of fire weather severity in Southeastern British Columbia using statistical downscaling *van der Kamp, Derek*	Projecting future glacier mass balance in the Coast Mountains of western Canada using distributed glacier mass balance model *Aryal, Raju*
Ocean Responses to Climate and Environmental Change PART 2 **Oak Bay 2**	Modelling the response of primary production to changes in freshwater runoff in the Estuary and Gulf of St. Lawrence *Lavoie, Diane*	Why the spring phytoplankton bloom is moving earlier in the year in the Strait of Georgia but later in the year in Rivers Inlet *Allen, Susan*	Coral reefs in a warming world: Lessons from the Central Equatorial Pacific *Donner, Simon*	The distribution of 231Pa and 230Th in the Pacific Ocean : A study from a 2D model *Luo, Yiming*	Ocean Climate Change in the Northwest Atlantic *Loder, John*	Modelling the future climate of the Gulf of St. Lawrence and Scotian Shelf; an application to snow crab habitat. *Chassé, Joël*
Celebrating the Scientific Career of Daniel G. Wright PART 2 **Esquimalt**	The International Thermodynamic Equation Of Seawater – 2010 (TEOS-10): The new oceanographic salinity and temperature variables and the implications for observational oceanography and for ocean modeling *McDougall, Trevor*		Better estimates of the physical properties of seawater in coastal regions *Pawlowicz, Rich*	Heat, salt and volume conservation in the N. Pacific *Freeland, Howard*	Rossby Waves and Current Bands in the Northeast Pacific *Stacey, Michael W.*	Seasonal and interannual sea level variations in the Northeast Pacific *Wakamatsu, Tsuyoshi*

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011						Session 3C
Session	1 13:30	2 13:45	3 14:00	4 14:15	5 14:30	6 14:45
Climate and carbon cycling in northern terrestrial ecosystems Sidney	Modelling Carbon Assimilation for Boreal Jack Pine Plantations – Ontario Long-term Soil Productivity (LTSP) – Canadian Carbon Program (CCP) *Reynolds, Phillip*	Carbon dioxide source/sink distribution in a mountain pine beetle attacked lodgepole pine stand *Emmel, Carmen*	Field estimates of sonic anemometer angle of attack errors *Kochendorfer, John*	Impact of drought-induced tree mortality on the carbon balance of a mature aspen forest *Barr, Alan*	Simulating future changes in permafrost and wetlands with the UVic Earth System Climate model *Avis, Chris*	
Climate prediction PART 1 Colwood	Statistical adjustment of decadal predictions *Kharin, Viatcheslav*	Comparison and validation of South Asian monsoon rainfall simulations using Community Climate System Models *Islam, Siraj ul*	Seasonal Predictions of East Asian-Western North Pacific Summer Monsoon in the Coupled Models *Yang, Dejian*	PNA Predictability at various time scales *Younas, Waqar*	A hybrid ensemble method for Argo data assimilation *Deng, Ziwang*	Experimental implementation of Sigma point Kalman filter for an ENSO prediction Model *Kizhakkeniyil, Manoj K*

Wednesday, 8 June 2011/Mercredi, 8 juin 2011					Session 3P
POSTER New Avenues in Forecast Verification (206) Carson Hall	Snow Comparison of Observed to Model Amounts during Snow-V10 *Brugman, Mindy*				
POSTER Numerical Weather Prediction (208) Carson Hall	Simulated Climatologies in Areas with Sparse Data Records: an Implementation of a Meteorological Information System *Lundgren, Jeff*	The two-moment bulk microphysics scheme in the GEM-LAM *Milbrandt, Jason*			

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Wednesday, 8 June 2011/Mercredi, 8 juin 2011					Session 3P
POSTER **Remote Sensing & Oceans** **(302)** **Carson Hall**	Regime shift temperature in the Red Sea *Prihartato, Perdana*				
POSTER **Celebrating the Scientific Career of Daniel G. Wright** **(307)** **Carson Hall**	Response of the Subpolar North Atlantic to persistent NAO-like forcing *Hayashida, Hakase*	Model study of the mesoscale variability in the western part of Labrador Sea *Demirov, Entcho*			
POSTER **George Boer Session on Climate Modelling and Analysis** **(401)** **Carson Hall**	Simulations Over West Africa With Version 5 Of The Canadian Regional Climate Model Are Analysed In Terms Of The Sensitivity To The Location Of The Domain And The Skill To Reproduce The Observed Climate *Tete, Kossivi Yewougni*				
POSTER **The role of the stratosphere in weather, climate and climate change** **(404)** **Carson Hall**	Comparing the lower stratospheric temperature trends over the past few decades in CCMVal 2 simulations *Lin, Pu*				
POSTER **Climate prediction** **(405)** **Carson Hall**	Skill of CHFP2 multi-seasonal forecasts: Comparison with ENSEMBLES, NCEP CFS and Environment Canada's current operational system *Lee, Woo-Sung*				

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011					Session 3P
POSTER Ocean Responses to Climate and Environmental Change (407) Carson Hall	Exotic visitors and warming events: west coast Vancouver Island *Galbraith, Moira*	Changing seasonal timing of marine zooplankton populations, and their link to ocean climate *Mackas, David*	Seasonal variations of organic-walled dinoflagellate cyst production in the Santa Barbara Basin: implications for paleoenvironmental reconstructions and harmful algal blooms *Bringué, Manuel*	Preliminary Results in Modeling Climate Change Along the British Columbia Coast *Callendar, Wendy*	Modelling shifts in seawater $\delta^{18}O$ due to glacial-interglacial sea ice variability *Brennan, Catherine*
POSTER Climate change and the carbon cycle (408) Carson Hall	Implementation of dynamic vegetation in the Canadian RCM *Garnaud, Camille*				
POSTER Application of Climate Model Results to Regional Adaptation (410) Carson Hall	Climate Change Adaptation Planning Using High-Resolution Remote Sensing *Davis, Taylor*	Climate change in the Atlin-Taku region of northern British Columbia *Sobie, Stephen*	A tool for evaluating climate change impacts at the forest stand level. *DeLong, Craig*		
POSTER Remote Sensing of the Ocean Surface - Synthetic Aperture Radar (501) Carson Hall	Impact of Band-Ratio Enhanced SAR Image for Sea Ice Types Discrimination *Nguyen, Nicolas Thai*				
POSTER Climate and carbon cycling in northern terrestrial ecosystems (701) Carson Hall	Soil climate implications for carbon flux modelling *Verseghy, Diana*	Modelling Carbon Assimilation for an Ontario Boreal Spruce Plantation -- Canadian Carbon Program (CCP) *Reynolds, Phillip*	Seasonal Soil Respiration (CO2 Eflux) Rates for Three Recently Harvested Ontario Boreal Forest Sites -- Canadian Carbon Program (CCP) *Reynolds, Phillip*	Effects of Forestry Operations on Soil Respiration (CO2 Eflux) by Intensively Managed Boreal Jack Pine Plantations -- Ontario Long-term Soil Productivity (LTSP) Study -- Canadian Carbon Program (CCP) *Reynolds, Phillip*	

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 juin 2011					Session 3P
POSTER Acoustics and Physical-Biological Interactions (706) Carson Hall	An Effective and In-Expensive Acoustic Test Tank Facility for High Frequency Active Sonar Instruments *Lemon, David*	Application of Spectral Nudging to NPZD-type Models. *Lagman, Karl Bryan*	Effect of the receiving environment on transport, fate and bio-uptake of contaminants from two submarine municipal outfalls. *Dinn, Pamela*	The sponge pump: the role of current induced flow in the design of the sponge body plan *Tunnicliffe, Verena*	
POSTER Atmosphere, Ocean, and Climate Dynamics (707) Carson Hall	Tracing air mass sources applying a temperature-independent model to stable water isotopes in precipitation *Jasechko, Scott*	Southern Hemisphere extra-tropical forcing on ENSO - Observation and Model Comparisons *Chen, Han-ching*	Dynamic Structure of a Subtropical Cyclone over the South Atlantic *Dutra, Livia*		
POSTER Soil Moisture, Streamflow, and Hydrologic Impacts of Climate Change (708) Carson Hall	A Heavy Rainfall Event Causing Flooding in Northern New Brunswick *Gabites, Charlotte*				

SCHEDULES / HORAIRE DES SESSIONS

Wednesday, 8 June 2011/Mercredi, 8 Juin 2011		Session 3E
Session	**1** **16:30**	**2** **17:00**
High Resolution Deterministic Prediction System Workshop **Saanich 1**	Towards an operational high resolution deterministic prediction system *Milbrandt, Jason*	Discussion of the Users' Needs for an Operational High Resolution Deterministic Prediction System / Discussion sur les besoins des utilisateurs pour une système opérationnelle de prévision déterministe a haute résolution *Milbrandt, Jason*
NSERC Workshop **Oak Bay 2**	NSERC Competition Results and "How to prepare a Discovery Grant application" / Résultats du concours du CRSNG et « Comment préparer une demande de subvention à la découverte » *Bowen, Dave*	
Ocean Hypoxia Town Hall Meeting **Esquimalt**		Ocean Hypoxia Town Hall / Discussion hypoxie dans l'océan *Grundle, Damian*
P. Met Certification Workshop **Sidney**	ECO Canada Workshop on Certification for Meteorologists: Professional Meteorologist – P. Met / D'ECO Canada Atelier sur la Certification pour les Météorologuse: Météorologiste professionnel – Mét. P. *Trump, Grant*	

SCHEDULES / HORAIRE DES SESSIONS

Thursday, 9 June 2011/Jeudi, 9 juin 2011						
08:20 The Weather Network/Météomédia weather briefing						
Plenary Day 4/Plénière jour 4 Lecture Theatre	8:30: Submesoscale Phenomena and Dynamics in the North Pacific Ocean; *Jim McWilliams* 09:15: Towards IPCC AR5: The Physical Science Basis - Emerging Questions, Structure of the Report and Schedule; *Thomas Stocker, Sponsored by Pacific Institute for Climate Solutions (PICS)*					Session 4A
						Session 4B
Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
Climate change and the carbon cycle PART 1 Lecture Theatre	Use of uniform CO2 concentration biases terrestrial carbon uptake in carbon-climate model simulations *Curry, Charles*	Uncertainty in the temperature sensitivity of forest soil decomposition and its impact on national-scale heterotrophic respiration estimates *Smyth, Carolyn*	Evaluating the effects of climate change and increasing CO2 on carbon budget of Chinese terrestrial ecosystems using processed model *Zhu, Qiuan*	Biosphere-atmosphere exchange at a mixed hardwood forest in Central Ontario subject to high nitrogen deposition *Geddes, Jeffrey*	Characterizing spatial representativeness of flux tower eddy-covariance measurements across the Canadian Carbon Program Network using remote sensing and footprint analysis *Chen, Baozhang*	Despite changes in C allocation, ecosystem carbon use efficiency is unaltered in temperate forest ecosystems at up to three times current atmospheric carbon dioxide concentrations and drought *Trueman, Rebecca*
New Avenues in Forecast Verification Saanich 1	New tools for evaluating spatial forecasts: MET and MODE *Brown, Barbara*		Investigations of Spatial Verification Techniques for Ensemble Forecasts of Precipitation during Heavy Precipitation Events along the United States West Coast *Tollerud, Edward*	Medium-Range Ensemble Forecast Verification for Users in the Energy Sector *Bourdin, Dominique*	A fair and equitable system for comparing the global models of the major NWP centres *Robinson, Tom*	What Is A Good Forecast: User-oriented verification *Wilson, Lawrence*
Application of Climate Model Results to Regional Adaptation PART 2 Oak Bay 1	Quantification of uncertainty in high resolution temperature scenarios for North America *Zwiers, Francis*	Climate model internal variability – the uncertainty required for adaptation *Braun, Marco*	Regional Climate Model results in Pacific North America and the northern Columbia Basin *Murdock, Trevor*	Objective climate scenario selection for impacts analysis and adaptation to climate change. *Logan, Travis*	Weighting factors of regional climate models combined with an evolution algorithm for the Southern Quebec region *Eum, Hyung-Il*	

SCHEDULES / HORAIRE DES SESSIONS

Thursday, 9 June 2011/Jeudi, 9 juin 2011 — **Session 4B**

Session	1 10:30	2 10:45	3 11:00	4 11:15	5 11:30	6 11:45
Atmosphere, Ocean, and Climate Dynamics PART 1 Oak Bay 2	Long Term Variability of the Kuroshio Transport East of Taiwan and the Climate it Conveys *Shen, Mao-Lin*	Topographic Drag in Ultra-Fine Resolution Global Simulations *Hamilton, Kevin*	The Probability Distribution of Land Surface Wind Speeds *Monahan, Adam*	On the dynamics of an abrupt climate change *Rose, Brian*	High resolution climate forcing of an ice sheet model with a global and regionally nested coupling scheme: Implications for modelling high latitude glacial initiation processes *Vettoretti, Guido*	
Celebrating the Scientific Career of Daniel G. Wright PART 3 Esquimalt	From process models to numerical models; the tools that Dan employed to advance our understanding of shelf sea circulation *Willmott, Andrew*		Using the All-Source Green's Function for Fast Responses in Storm Surges *Xu, Zhigang*	Forcing mechanisms for variations of sea surface height and circulation in the North Atlantic *Wang, Zeliang*	The tilt of mean sea level along the east coast of North America: Can it be explained by the large scale ocean circulation? *Higginson, Simon*	Processes impacting model drift in the sub-polar gyre in eddy permitting simulations *Myers, Paul*
Acoustics in Oceanography Sidney	Long-term methane flux measurements from underwater gas seeps using passive and active acoustics *Vagle, Svein*	Measurement of turbulent large-eddy velocities with a 5-beam VADCP: present results and future promise *Gargett, Ann*	Acoustic Doppler Velocimetry from the VENUS Coastal Network *Dewey, Richard*	Seasonal cycle of multi-frequency acoustic backscatter in the water column of Barkley Sound, British Columbia *Pawlowicz, Rich*	One year of detecting fish movements with a Doppler profiler on the VENUS Ocean Observatory *Zedel, Len*	A review on acoustic estimation of migratory fish abundance in the lower Fraser River *Xie, Yunbo*
Climate prediction PART 2 Colwood	Dreams of decadal prediction *Boer, George*		Contrasting Decadal Predictability Characteristics of Six CGCMs *Branstator, Grant*	Do decadal hindcasts capture the recent pause in global warming? *Fyfe, John*	Coupled ice sheet/climate simulations of Greenland evolution in coming millennia: ice volume evolution and sensitivity to model parameters *Fyke, Jeremy*	Impact of the 2007 Arctic sea ice reduction in coupled ocean-atmosphere autumn hindcasts *Orsolini, Yvan*

Thursday, 9 June 2011/Jeudi, 9 juin 2011 — **Session 4X**

Session	1 12:00 - 13:00
Ocean Science Coalition Town Hall Meeting Sidney	Ocean Science Coalition Town Hall Meeting / Séance de discussion ouverte de la coalition des sciences oceanographiques *Roberta Hamme and Adam Monaham*

SCHEDULES / HORAIRE DES SESSIONS

Thursday, 9 June 2011/Jeudi, 9 juin 2011						Session 4C
Session	1 13:30	2 13:45	3 14:00	4 14:15	5 14:30	6 14:45
Climate change and the carbon cycle PART 2 Lecture Theatre	Photochemical Production of Dissolved Inorganic Carbon from Three Algal Cultures: Implications for Iron Fertilization *Loos, Eduardo*	Millennial-scale impacts of marine biogenic calcification perturbation on ocean carbon cycling *Pinsonneault, Andrew*	An important impact of Southern Hemisphere surface winds on global ocean carbon uptake and storage *Swart, Neil*	Biogeochemical Modelling in Canada's High Latitude Oceans *Steiner, Nadja*	The effect of changing radiant energy on carbon transformations in the Arctic Ocean *Johannessen, Sophia*	Observationally-based datasets for ocean acidification modelling *Matthews, Robin*
George Boer Session on Climate Modelling and Analysis PART 1 Saanich 1	On the role of statisticians and the study of predictability *Zwiers, Francis*		Impact of model configuration on nested RCMs' added value and internal variability *Laprise, J.P.R.*		Decadal Prediction and Predictability *Kirtman, Ben*	Validation of CRCM5 simulations over Africa *Winger, Katja*
Validation of empirical-statistical downscaling methods in a varying climate system PART 1 Oak Bay 1	Comparative extended validation of statistical and dynamical downscaling models *Huth, Radan*		BCSD Downscaled Transient Climate Projections for Eight Select GCMs over British Columbia, Canada *Werner, Arelia*	Validating the downscaling of Climdex extremes for multiple methods *Buerger, Gerd*	Validation of statistical downscaling methods in terms of weather and climate: Surface temperature in Southern Ontario and Quebec *Gaitan Ospina, Carlos*	Dynamical and statistical downscaling comparisons: assessment of regional changes in climate variability and extremes *Gachon, Philippe*
Atmosphere, Ocean, and Climate Dynamics PART 2 Oak Bay 2	Transport of a quasigeostrophic circumpolar current *Straub, David*	The generation of submesoscale dynamics in wind-driven gyres *Poulin, Francis*	Smoluchowski Coagulation Models And Sea Ice Thickness Distribution Dynamics *Godlovitch, Daniel*	Three-dimensional simulation of waves generated by crater topography *Soontiens, Nancy*	Resonant generation of internal waves by short length scale topography *Stastna, Marek*	Quantifying the uncertainty of the climate change signal and the inter-model spread in the context of an ensemble of opportunity *Leduc, Martin*
Remote Sensing & Oceans Esquimalt	Satellite Observations of Canada's Oceans – Current Activities by Fisheries and Oceans Canada *Joseph, Helen*		Use of satellite measurements to understand interannual variability of the Northeast Pacific Ocean. *Crawford, Bill*	Coastal Ocean Colour: Spatial-Temporal Variability and Detection Challenges in the Strait of Georgia, British Columbia, Canada *Loos, Eduardo*	Practical application of satellite remote sensing to the coastal waters of Atlantic Canada *Bugden, Gary*	Decline and rebound of the Labrador Current over 1993-2004 *Han, Guoqi*

SCHEDULES / HORAIRE DES SESSIONS

Thursday, 9 June 2011/Jeudi, 9 juin 2011						Session 4C
Session	1 13:30	2 13:45	3 14:00	4 14:15	5 14:30	6 14:45
Physical-Biological Interactions in Aquatic Environments PART 1 Sidney	Seasonal variability of phytoplankton production in the Straits of Georgia and Juan de Fuca *Pena, Angelica*		Physico-chemical factors affecting microalgal bloom dynamics in a coastal lagoon *Kobryn, Arielle*	Understanding the upstream coastal spread of Aquatic Invasive Species (AIS) in Maritime Canada *Brickman, David*	Habitat drivers of organic biomass inventory and production of benthos in the Strait of Georgia *Burd, Brenda*	The role of trophic and size structure in the stability and productivity of soft-bottom invertebrate communities *Macdonald, Tara*
Renewable Energy - The Important Role of Meteorological and Oceanographic Sciences PART 1 Colwood	British Columbia's emerging renewable energy landscape – the role of BC Hydro and the weather prediction community *McCollor, Douglas*	Wind Monitoring for Wind Energy in Ontario *Corkum, Matthew*	Improvement to mesoscale wind climate modelling in cold climate steep mountains *Pham, Philippe*	Wind farm power forecasting using numerical weather prediction model *Touani Tchanko, Joseph Ismael*	Prediction of High Impact Events on Wind Power Productions *Yu, Wei*	Site Specific Canadian Lightning Climatology: Application for Wind Turbine Lightning Protection *Shephard, Mark*

Thursday, 9 June 2011/Jeudi, 9 juin 2011						Session 4D
Session	1 15:30	2 15:45	3 16:00	4 16:15	5 16:30	6 16:45
Climate change and the carbon cycle PART 3 Lecture Theatre	An overview of the effects of historical land cover change on climate and the carbon cycle *Pongratz, Julia*	Are estimates of past carbon cycle - climate feedbacks useful indicators of future feedbacks? *Eby, Michael*	Why is global warming proportional to cumulative carbon emissions? *Gillett, Nathan*	Is the climate response to carbon emissions path dependent? *Zickfeld, Kirsten*	Cumulative carbon as a policy framework for avoiding dangerous climate impacts *Matthews, Damon*	Future CO2 emissions and climate change from existing energy infrastructure *Davis, Steven*
George Boer Session on Climate Modelling and Analysis PART 2 Saanich 1	Large-scale two-dimensional turbulence in the atmosphere? *Shepherd, Theodore*		Cloud Feedbacks and Global Climate Sensitivity *Hamilton, Kevin*	Climate Correlation Length *Li, Jiangnan*	Issues of spectral nudging and domain size in studies of limited- area RCM response to modification *Separovic, Leo*	Chaos in Regional Climate Model simulations: Budget diagnostics of internal variability *Nikiema, Oumarou*
Validation of empirical-statistical downscaling methods in a varying climate system PART2 Oak Bay 1	Preliminary evaluation of the simple agrometeorological indices from the gridded data set(1961 to 2003) *Chipanshi, Aston*	ClimateWNA: Access to high spatial resolution climate data for western North America *Spittlehouse, David*	Statistical Downscaling of Sea Surface Winds in the Subarctic Northeast Pacific *Monahan, Adam*	Statistical downscaling of historical land surface winds over the Canadian prairies and central Canada: exploring prediction skill. *Culver, Aaron*	No validation, but consistency *Buerger, Gerd*	

SCHEDULES / HORAIRE DES SESSIONS

Thursday, 9 June 2011/Jeudi, 9 juin 2011						Session 4D
Session	**1** **15:30**	**2** **15:45**	**3** **16:00**	**4** **16:15**	**5** **16:30**	**6** **16:45**
General Atmospheric Science Oak Bay 2	The Lake Ontario Land Breeze Snow Band *Tugwood, Bryan*	Interesting Aspects of the Cobequid Pass Snowstorm / Aspects intéressants de la tempête de neige de Cobequid Pass *Pilon, Mark*		The 2010 Harrow-Leamington Tornadoes *Meredith, Mitchell*	Temperature, precipitation, and lightning modification in the vicinity of the Athabasca oil sands *Brown, Daniel*	
Remote Sensing of the Ocean Surface - Synthetic Aperture Radar Esquimalt	National SAR Winds Project in Canada *Zabeline, Vladimir*	Results From the National SAR Winds Project Forecasters Evaluation *Fogarty, Chris*	Comparison of SAR marine wind with GEM-LAM atmospheric models in the Arctic *Bergeron, Thomas*	Wind speed retrieval based on RADARSAT cross-polarization channels *Zabeline, Vladimir*	Training Requirements for Effective Operational Utilization of SAR Winds by the Meteorological Service of Canada *Neil, Laurie*	
Physical-Biological Interactions in Aquatic Environments PART 2 Sidney	Copepod legs — surface area vs. body size and potential swimming ability, a comparison of eight species *Allen, Susan*		Characteristics of diel vertical migration: bio-acoustic time-series from the VENUS network *Sato, Mei*	Co-incident in-situ observations of turbulence and zooplankton with a new biophysical profiler *Ross, Tetjana*	Quantifying Loss Terms in a Fjord Mesozooplankton Community: Advection and Mortality *Tommasi, Desiree*	
Renewable Energy - The Important Role of Meteorological and Oceanographic Sciences - PART 2 Colwood	"Wind Energy in Canada; the basics, the resource and the opportunity" - making an educational video. *Taylor, Peter*	A model of ice throw trajectories from wind turbines *Biswas, Sumita*	Numerical studies of tidal power potential. *Walters, Roy*	Heavy snowfall of January 2011 in the Columbia region of British Columbia: synoptic overview and impacts on BC Hydro short and long term operations *Ashman, Tim*	High-Resolution Hydrometeorological Modeling for the Prediction of a Significant Reservoir Inflow Event *Bourdin, Dominique*	The Integral Fast Reactor (IFR): An Optimized Source for Global Energy Needs *Ware, Randolph*

Thursday, 9 June 2011/Jeudi, 9 juin 2011	Session 4E
Plenary Public Lecture/Plénière Conférence Publique -- Lecture Theatre	19:30: Exploring ocean frontiers - we have more to learn; *Verena Tunnicliffe*

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ISBN: 978-0-9732812-9-3

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1C5.2 ID:4708 14:30

Ocean climate, variability and change on CanESM2

William Merryfield
Canadian Centre for Climate Modelling and Analysis
Contact: bill.merryfield@ec.gc.ca

CanESM2 is CCCma's latest climate system model and is the basis for the Canadian modelling contribution to the IPCC Fifth Assessment. This talk focuses on CanESM2's representation of ocean climate, unforced variability on interannual to multidecadal time scales, and forced changes in the 20th and 21st centuries.

4C1.2 ID:4709 INVITED/INVITÉ 14:00

Impact of model configuration on nested RCMs' added value and internal variability

René Laprise
(Presented by *J.p.r. Laprise*)
ESCER, Earth and Atmospheric Sci., Université du Québec à Montréal
Contact: laprise.rene@gmail.com

The ansatz behind the dynamical downscaling technique is that a Regional Climate Model (RCM), driven by large-scale atmospheric fields at its lateral boundary, generates fine scales that are dynamically consistent with the large scales. RCM are expected to act as a kind of magnifying glass that reveals details that could not be resolved on a coarse mesh. The small scales represent the main potential added value of high-resolution RCM. Almost 20 years after the inception of RCMs, several methodological issues still remain, including the choice of domain size, its location, and the nesting technique. A series of methodical investigations spread over the course of several years have been performed to address these issues in an unambiguous manner, following a strict experimental protocol: the Big-Brother Experiment. The results to date point to the advantage of using rather large domains to permit the full spin-up of small scales, acknowledging however that such configuration permits the intermittent occurrence of large internal variability and divergence in phase space of RCM simulations. Alternative nesting techniques to the traditional imposition of lateral boundary conditions, which allow forcing the large scales throughout the domain, appear to offer certain advantages.

3P707.3 ID:4710 15:30

Dynamic Structure of a Subtropical Cyclone over the South Atlantic

Livia Dutra , *Rosmeri Rocha* , *Ricardo Camargo* , *Jean Peres*
IAG/USP
Contact: livia.dutra@uol.com.br

In the first week of March 2010, a surface cyclone developed on the coast of Brazil at approximately 19 º S. This system showed an anomalous shift to the southwest until it reached the vicinity of the southern coast of the country, where it was absorbed by another cyclonic system and finally started to move to the southeast. This system was responsible for rain and strong winds that caused extensive damage in some coastal regions, such as floods and landslides. The aim of this study is to investigate

the synoptic, dynamic and thermodynamic processes related to this cyclonic disturbance. The importance of each term of the vorticity and heat budgets was analyzed in each stage of its life cycle in order to identify the dominant processes responsible for the cyclonic and temperature trends. This analysis was made from a Lagrangian description, which allowed evaluating the average contribution of each term of the equations throughout the atmospheric column and at each stage of the cyclone. The spatial distribution of the terms in different levels of pressure was also evaluated. In the middle troposphere, there was a strong correlation between areas of cloud and areas of greatest diabatic heating, showing the temperature increase due to the effects of the release of latent heat through the condensation of water vapor. In the upper troposphere, it was found some regions where the convective processes could explain the observed vorticity imbalances. For other regions and levels at which there was no direct relationship between the residual fields, it is suggested that convection influences the local variations of vorticity in a more distributed way in the atmospheric column, as well as the divergence associated with the upward movements can be more distributed throughout the troposphere, without being concentrated at only some levels.

3P401.1 ID:4711 15:30

SIMULATIONS OVER WEST AFRICA WITH VERSION 5 OF THE CANADIAN REGIONAL CLIMATE MODEL ARE ANALYSED IN TERMS OF THE SENSITIVITY TO THE LOCATION OF THE DOMAIN AND THE SKILL TO REPRODUCE THE OBSERVED CLIMATE

Kossivi Yewougni Tete , *René Laprise*
Centre ESCER (Étude et Simulation du Climat à l'Échelle Régionale), UQAM
Contact: tete@sca.uqam.ca

West African (WA) is affected in recent years by climatic extremes of drought and floods. Adaptation options were taken, but are insufficient for agricultural production. A major challenge for people is to anticipate and adapt to these extreme weather events. It is in this vein that our study addressed the sensitivity of the Canadian Regional Climate Model (CRCM, version 5) to domain location and its reliability in reproducing the observed climate in WA. The first part of this study is to analyze the sensitivity of the location of the CRCM domain. For this purpose, a set of four simulations covering WA was performed with the CRCM. These simulations differ from each other only in the location of the integration domain. Internal variability is evaluated as the differences between these simulations during the integration period. Preliminary results show that the convective zones correspond to areas of maximum internal variability, and lateral boundary conditions have little influence on precipitation. Indeed, precipitation depend heavily on local forcings. The second part is to assess the reliability of the MRCC to simulate the observed climate in WA. To meet this goal, the CRCM outputs are compared with available observations. The preliminary results show that the CRCM adequately defines the area of the monsoon. Some shortcomings regarding the intensity of the monsoon flows, however, are noted.

1P406.3 ID:4712 16:00

The influence of the sea surface temperature on the interannual variability and potential predictability of the mean seasonal atmospheric conditions

Elisabeth Viktor , *Hai Lin* , *Jacques Derome*
McGill University
Contact: elisabeth.viktor@mail.mcgill.ca

A climate simulation over a period of 20 years performed with the atmospheric general circulation model GEM-CLIM and forced by observational sea surface temperature (SST) and sea-ice extent was examined in terms of the variability of seasonal mean 500hPa geopotential height (Z500) in the northern hemisphere. The external variability of Z500 due to forcing by the SST at the bottom boundary was estimated by a separation from the total variability through an SVD analysis. The residual was assumed to be internally generated variability without temporal correlation with the forced variability. Potential predictability is expected in areas where the SST-linked variability significantly exceeds the variability due to internal mechanisms. In winter, the possibility of prediction is found to be high in the tropics as well as over the region of the PNA pattern. The mid-latitudes are influenced by SST anomalies of El Niño/La Niña events in the tropical Pacific through teleconnections. A lag between the SST forcing and Z500 improves the possibility of prediction. For October mean SST and DJF Z500, the potential predictability of Z500 strengthens and expands over the North Atlantic. In the months March to May, the external forcing in general decreases. However, apart from weaker but still significant signals over the Pacific and North America, an NAO-like pattern of potential predictability arises over Europe. The results replicate previous findings using different models and/or methods of analysis, but emphasize that the North Atlantic plays an important role in potential predictability as well.

3B2.3 ID:4713 11:15

Analysis and Inter-Comparison of Multiple RCM based Hydro-Climate Scenarios in the Lake Winnipeg Watershed

Yonas Dibike [1], *Terry Prowse* [2], *Roxanne Ahmed* [3]
[1] Environment Canada
[2] Environment Canada / University of Victoria
[3] University of Victoria
Contact: yonas.dibike@ec.gc.ca

This study evaluated hydro-climate data from the North American Regional Climate Change Assessment Program (NARCCAP) over the Lake Winnipeg watershed (LWW) for the baseline (1971-2000) and future (2041-2070) periods. The data is derived from a set of regional climate models (RCMs) driven by global reanalysis (NCEP) and a set of General Circulation Models (GCMs) based on the SRES A2 emissions scenario. Precipitation and temperature outputs from the GCM driven RCMs are compared with the NCEP driven RCMs as well as observed 10 km Gridded Climate Dataset for Canada for the period 1981-2000. The results show that both NCEP and GCM driven RCMs have significant biases in seasonal temperature and precipitation compared to the gridded observed data. Climate change analyses based on future projections indicated that annual precipitation in the region is projected to increase by a combined model average (ensemble mean) of about 6.5%, while seasonally increases are projected for the winter, spring and fall and a decrease in the summer. Maximum and minimum daily temperatures are also projected to increase in the region, with mean annual Tmax increase of 2.6 - 2.9 °C and mean annual Tmin increase of 2.4 - 2.8 °C. Temperature increases will be most noticeable in the winter and summer. Furthermore, the future projection form CRCM also shows an average decrease in the annual maximum snow pack (SWE) by about 4.5% and the mean snow cover duration (SCD) by about 17 days in most parts of the LWW. There is also an overall increase in total annual runoff projected for most river basins and an over all shift in spring runoff to an earlier period. These projected changes in the hydro-climate regimes of the LWW will have important implications for the nutrient transport regimes of this region, which needs additional investigation using hydrologic and nutrient transport models.

2D3.1 ID:4714 16:00

Overlap of Solar and Infrared Spectra and its Climate Impact

Jiangnan Li
canadian center for climate modelling and analysis
Contact: jiangnan.li@ec.gc.ca

In most climate models, the solar spectrum comprises wavelengths shortward of 4 micro meter with all incoming solar energy deposited in that range. In reality, however, the solar spectrum extends into the infrared, with about 12 W per square meter in the 4--1000 micro meter range. In this paper a simple method is proposed wherein the longwave radiative transfer equation with solar energy input is solved. In comparison with the traditional method, the new solution results in more solar energy absorbed in the atmosphere and less at the surface. We also present 10-year GCM simulations showing the detailed climatic effect of the change in radiation treatment. It is demonstrated that the inclusion of solar flux in the infrared range produces a significant amount of extra warming in the atmosphere, specifically: (i) in the tropical stratosphere where the warming can exceed 1 K/day; and (ii) near the tropical tropopause layer.

4D1.3 ID:4715 16:15

Climate Correlation Length

Jiangnan Li
canadian center for climate modelling and analysis
Contact: jiangnan.li@ec.gc.ca

Based on the method of point-correlation, people have obtained the climate patterns, like PNA, NA, and NAO, etc. However, the physics of the point-correlation method has seldom been paid attention in the atmospheric field. The similar problem was intensively investigated in statistical physics. Though Landau-Ginsberg expansion, the correlation length is obtained which indicates the correlation strength at each location in a fluctuated medium. In this talk the concept and calculation method of correlation length will be introduced. Also the brief result by applying it in climate study will be presented.

1P502.3 ID:4716 16:00

Energy Balance at the Air-Sea Interface of the Tropical Atlantic Ocean

Livia Dutra , *Jacyra Soares*
IAG/USP
Contact: livia.dutra@uol.com.br

The main goal of this work is to characterize the radiometric parameters of the atmosphere and of the ocean in the Saint Peter and Saint Paul Archipelago (SPSPA) region, located in the tropical Atlantic Ocean. The SPSPA is formed by a group of small uninhabited rocky islands, which are devoid of any kind of vegetation, and it is located about 1.010 km from the Brazilian coast, in a prime position for the development of meteorological and oceanographic researches. This work is connected to the FluTuA project (Turbulent Fluxes over Atlantic), that uses a ten meter micrometeorological tower installed at the SPSPA, to investigate the ocean-atmosphere interaction through the observation of meteorological parameters in the Tropical Atlantic ocean. Initially, this work used internet available data measured in situ from the PIRATA (Pilot Research Moored Array in the Tropical Atlantic) oceanographic buoys and data of programs of research that estimate variables using different algorithms (reanalysis data). Through the temporal evolution of the shortwave radiation incident at the

top of atmosphere and on the air sea interface it was possible to verify the occurrence of clear-sky days during the available period. To obtain the energy balance over the region it was carried out a characterization of the sensible and latent heat turbulent fluxes in the ocean-atmosphere interface, as well as the characterization of the radiation balance components (shortwave and longwave). Yet, this work investigated the diurnal and annual evolution of the atmospheric and surface radiometric properties (transmissivity and albedo, respectively).

2B4.4 ID:4717 11:15

A Circulation Model for the Discovery Islands, British Columbia

Michael Foreman [1], *Dario Stucchi* [1], *Kyle Garver* [2]
[1] Institute of Ocean Sciences, DFO
[2] Pacific Biological Station, DFO
Contact: mike.foreman@dfo-mpo.gc.ca

A finite volume, ocean circulation model is applied to the Discovery Islands region of British Columbia and used to simulate the three-dimensional velocity, temperature, and salinity fields that will be required by a companion biological transport model. The circulation model is initialized with a combination of climatological and recent temperature and salinity observations, and forced with i) winds measured at seventeen weather stations, ii) the discharges from eleven rivers, and iii) five tidal constituents. A simulation for the period of April 1 to April 28, 2010 is evaluated against simultaneous observations from three current meter moorings and the harmonics computed from historical measurements at twenty-four tide gauges. Though the model tidal elevations are shown to have excellent agreement with the observations, profiles of model tidal speed versus depth generally do not capture observed vertical variations as well. Future work to overcome model deficiencies will be briefly outlined.

3B3.6 ID:4718 11:45

Trends in Upwelling and Downwelling Winds along the British Columbia Shelf

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

Fifty-year time series of winds at six buoys off the British Columbia coast are examined for trends in the timing and cumulative intensity of upwelling and downwelling. Unlike a similar analysis to the south, the onset of upwelling is not found to be progressing later in the year. However, statistically significant trends toward increased cumulative upwelling and downwelling are found at most buoys and this is related to previous findings of trends in sea level pressure and winter mixed layer depth in the Northeast Pacific. Implications for past and future local marine ecosystems will be briefly discussed.

3C4.1 ID:4719 INVITED/INVITÉ 13:30

The International Thermodynamic Equation Of Seawater – 2010 (TEOS-10): The new oceanographic salinity and temperature variables and the implications for observational oceanography and for ocean modeling

Trevor Mcdougall
CSIRO
Contact: Trevor.McDougall@csiro.au

The Thermodynamic Equation of Seawater - 2010 (TEOS-10 for short) has been adopted by SCOR, IAPSO, IAPWS and IOC as the new thermodynamic description of seawater for both engineering and oceanographic research purposes. This thermodynamic description of seawater, ice and humid air provides accurate algorithms for density, entropy, enthalpy and many other properties such as freezing temperature and evaporation enthalpy. TEOS-10 involves a new salinity variable, Absolute Salinity, and a new temperature variable, Conservative Temperature which replaces potential temperature in physical oceanography. The decisive and insightful contributions of Dan Wright to these new concepts will be emphasized in the talk. The changes that are now required in ocean models will also be summarized.

2D6.1 ID:4720 INVITED/INVITÉ 16:00

Tracer-Contour Inversion: pathway to global mixing fields?

Trevor Mcdougall
CSIRO
Contact: Trevor.McDougall@csiro.au

The main aim of physical oceanography, both observational and theoretical, since it began as a discipline in about 1900 was to estimate the ocean circulation. In the last 25 years we have been so bold as to also ask about the strength of ocean mixing processes, mostly because our climate models need to know. Starting in 1978 three inverse methods have been invented to use hydrographic data in order to estimate the ocean circulation and mixing processes; one was by Carl Wunsch of MIT, one by Hank Stommel of Woods Hole, and one by Peter Killworth of the UK. These inverse methods have been the basis for many (perhaps 100) PhD thesis and they have had some skill in pinning down the ocean circulation, but they have had limited success in estimating the mixing strengths or in providing estimates for the rates of formation of subducted waters (e.g in the Southern Ocean). The Tracer-Contour Inverse Method builds on both Killworth's Bernoulli method and the box model method to provide a very clean set of equations in which the advection/diffusion balance is represented; there is no longer a need to assume a level of no motion. Also, the method is ideally set up to estimate the rate of subduction of water masses from the sea surface into the ocean interior. The first three papers (all with Jan Zika as lead author) have proven the value of the method in regions of the ocean that are approximately ten degrees of latitude and longitude on a side. The method has proven able to deduce the strength of diapycnal mixing even when it is very small. The fact that the diapycnal diffusivity increases with depth and the lateral diffusivity decreases with depth comes clearly out of the model results.

3C5.5 ID:4721 14:30

Simulating future changes in permafrost and wetlands with the UVic Earth System Climate model

Chris Avis
University of Victoria - School of Earth and Ocean Science
Contact: caavis@uvic.ca

Wetlands are vegetated regions that are inundated on a permanent, seasonal or intermittent basis. Wetlands play an important role in the carbon cycle through carbon uptake and storage in vegetation and soil and through carbon dioxide and methane release from bacterial decomposition of organic matter. Over 50% of wetlands are located in the high northern latitudes where regions of seasonally and perennially frozen ground (permafrost), exert a high degree of control on their hydrology. Recent observations have linked the degradation of permafrost to changes in the abundance of Arctic lakes: from 1973-2004, the abundance and total area of lakes increased in continuous permafrost zones, but decreased in other permafrost zones. Here we use a global climate model, the UVic Earth System Climate Model to demonstrate a strong link between high-latitude northern wetlands and the state of permafrost. The model has recently been upgraded to include a representation of soil freeze/thaw processes.We simulate changes in the global climate to year 2500 following the recently released Representative Concentration Pathways. We show that, as permafrost degrades, the overall areal extent of wetlands decreases. The number of days that these seasonal wetlands are present in regions with remaining permafrost initially increases through a lengthening of the thaw season, but this is followed by a dramatic decrease once the permafrost table begins to rapidly deepen. We identify a surface soil temperature threshold above which this rapid transition to wetland reduction occurs.

3P408.1 ID:4722 15:30

Implementation of dynamic vegetation in the Canadian RCM

Camille Garnaud [1], *Laxmi Sushama* [1], *Vivek Arora* [2], *Katja Winger* [1]
[1] UQAM département des sciences de la Terre et de l'atmosphère, réseau MDCR
[2] Canadian Centre for Climate Modelling and Analysis
Contact: camille@sca.uqam.ca

Though vegetation forcings are overall weaker than climate forcings, it can influence the climate by means of three types of interactions: biophysical interactions, related to the energy and water balance, biogeochemical interactions, related to the sources and sinks of atmospheric gases like CO2, and biogeographical interactions, related to the distribution of vegetation. The Canadian RCM (CRCM5) currently represents vegetation as a static component. In this framework, while the specified vegetation structural attributes influence the state of the climate, the vegetation itself is not allowed to respond to the simulated climate. The Canadian Terrestrial Ecosystem Model (CTEM), which simulates vegetation as a dynamic component of the climate system, has recently been coupled to the latest version of the Canadian Land Surface Scheme (CLASS3.5). CTEM grows vegetation from bare ground and includes processes of photosynthesis, autotrophic and heterotrophic respiration, phenology, turnover, allocation, fire, and land-use change. Implementation of the coupled CLASS3.5/CTEM model in CRCM5 is currently in progress, which will facilitate modelling of vegetation as a dynamic component and simulation of CO2 fluxes between the land and the atmosphere in CRCM5. Some preliminary results of the evaluation and analysis of CLASS3.5/CTEM offline simulation over North America will be presented along with CRCM5/CLASS3.5/CTEM coupling strategies and future plans.

2C2.3 ID:4723 14:45

Canadian Snow Cover Mapping Through Assimilation of Satellite Radiances and CMC Snow Depth Analysis

Richard Fernandes [1], *Ross Brown* [2], *Bruce Brasnett* [2], *Matt Gingerich* [1], *Ryan Ahola* [1]

[1] Canada Centre for Remote Sensing
[2] Environment Canada
Contact:

Consistent Canada wide snow cover maps are essential information for climate, ecosystem and natural resource applications. Current in-situ measurements are sparse and restricted to snow depth resulting in reduced accuracy for large area snow depth analyses. Satellite imaging can provide relatively accurate snow cover maps but only for cloud free conditions. Here we report on a new data assimilation system for continuous snow cover mapping across Canada using observables of both CMC snow depth analyses and satellite radiances and forcings from CMC analyses. The implementation relies on a non-parameteric particle filter to assimilate radiances, snow depth and snow density fields. Daily snow cover maps for Canada spanning 2005-2009 are produced. Comparison to in-situ snow depth measurements and to MODIS snow cover products are presented.

4D1.1 ID:4724 INVITED/INVITÉ 15:30

Large-scale two-dimensional turbulence in the atmosphere?

Theodore Shepherd
University of Toronto
Contact: tgs@atmosp.physics.utoronto.ca

Boer & Shepherd (1983) examined the newly available FGGE global atmospheric analysis to test the then-fashionable theoretical hypothesis that the large-scale atmospheric flow behaved in a manner consistent with the predictions of two-dimensional turbulence theory. The paper has since become a classic reference in the subject. It is generally cited in support of this hypothesis, particularly of the upscale energy cascade that is the hallmark of two-dimensional turbulence. Recent studies have argued instead that the atmospheric general circulation exhibits weak nonlinearity, with only a very limited role for the sort of upscale energy cascade predicted by two-dimensional turbulence theory. This apparent dichotomy will be discussed in the light of theoretical developments over the last 30 years.

3B0.1 ID:4725 INVITED/INVITÉ 10:30

The coupled stratosphere-troposphere response to climate change

Theodore Shepherd
University of Toronto
Contact: tgs@atmosp.physics.utoronto.ca

The stratosphere represents the upper boundary condition for the troposphere, but it is a non-trivial upper boundary condition with two-way couplings that are only beginning to be elucidated. This talk will discuss some of these couplings in the context of climate variability and climate change, focusing on the role of wave, mean-flow interactions involving both the subtropical jet and the stratospheric polar vortex. Recent advances will be presented and open questions identified.

4B0.2 ID:4726 10:45

Uncertainty in the temperature sensitivity of forest soil decomposition and its impact on national-scale heterotrophic respiration estimates

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

Soil organic matter is the largest carbon (C) pool in terrestrial ecosystems, and plant detritus and soil account for most of total forest C in Canada. Understanding decomposition dynamics is of critical policy and scientific importance to quantify the current and future C cycle. The temperature sensitivity of decomposition is important, because if heterotrophic respiration (Rh) of most dead organic C is enhanced by warming, then the emissions from forests could increase in a warmer world, contributing to positive feedback to global temperatures.

In this study, C stock measurements from nearly 600 ground plots were used to estimate a range of plausible temperature sensitivities of decomposition in the organic soil horizon and mineral soil within the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3). The top ten best-fitting combinations of decay rates and temperature sensitivities were estimated by minimizing the residual error between predictions and measurements.

Impacts on annual Rh for the 230 Mha of Canada's managed forest were estimated for the ten combinations of decay parameters with Q10 values of 1 to 1.5 for mineral soil C and 2 to 4 for soil organic horizon and associated decay rates. The maximum difference in Rh estimates for the ten simulations was 0.78% of the average Rh in 1990, and 2.9% under a warming scenario (+6°C) in 2100. The result that there was only a small difference between predicted annual Rh estimates under a range of temperature sensitivities can be explained in part because temperature quotients of the mineral soil were one for nine of the ten parameter sets. These results of this analysis suggest that soil decomposition may result in a weaker positive feedback than is currently predicted by models which assume mineral soil respiration is sensitive to temperature.

1C6.4 ID:4727 14:45

Possible Impacts of Climate Change on Snowfall and Snow Depth over Northern Canada under Downscaled Future Climate Conditions

Chad Shouquan Cheng [1], *Baoling Wang* [2]
[1] Science Section, Meteorological Service of Canada Operations - Ontario, Environment Canada
[2] Adaptation & Impacts Research Section, 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 and daily snow depth under downscaled future climate conditions over Northern Canada. The 55-year historical data, including hourly/daily meteorological observations, were used to develop daily snowfall and snow depth simulation models. In addition, nine GCM outputs with two IPCC AR4 scenarios (A2 and B1) were used in the study for future two-time windows (2046–65, 2081–2100). The GCM historical 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 and daily snow depths. Downscaling transfer functions and snowfall/snow depth simulation models were validated using a cross-validation scheme and comparing data distributions and extremes derived from downscaled GCM historical 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/snow depth 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 and snow depth.

1P403.3 ID:4728 16:00

Hydrological extremes in the Fraser River Basin

Stephen Dery , *Phil Owens* , *Ellen Petticrew* , *Margot Parkes*
UNBC
Contact: sdery@unbc.ca

The Fraser River drains one quarter of British Columbia and is its greatest river by annual discharge at over 100 cubic kilometres. As the most productive salmon river in the world, it remains an important river economically and culturally. The subsistence of many First Nation communities depends on salmon fishing along the many tributaries of the Fraser. Freshwater extracted from the Fraser River is used in many industries including agriculture, mining, pulp mills and forestry. Despite its national and international importance, recent streamflow variability and trends across the Fraser River watershed are poorly known. This presentation will provide an analysis of the interannual variability and interdecadal trends in discharge of the Fraser River along its main stem and its tributaries from 1910 to 2009. Data from over 100 gauges will be assessed to infer the variability and trends in annual discharge, including the occurrence of hydrological extremes. The talk will end with a discussion on the possible implications of climate change on the observed variability and trends.

1C1.2 ID:4729 INVITED/INVITÉ 14:30

Thermodynamic and Liquid Profiling at the Alpine Venue of the 2010 Winter Games

Randolph 'Stick' Ware [1], *Domenico Cimini* [2], *Graziano Giuliani* [2], *Edwin Campos* [3], *Jeos Oreamuno* [4], *Ismail Gultepe* [5], *Paul Joe* [5], *Stewart Cober* [5], *Steve Albers* [6], *Steven Koch* [6]
[1] Radiometrics, NCAR, CIRES (US)
[2] University of L'Aquila (Italy)
[3] Argonne National Laboratory (US)
[4] Radiometrics (US)
[5] Environment Canada
[6] NOAA Global Systems Division (US)
Contact: ware@radiometrics.com

Environment Canada operated a microwave profiling radiometer at the Whistler Timing Flats site as part of SNOW-V10 (a WMO-EC winter nowcasting in mountainous terrain research project). The radiometer retrieved continuous (every minute) temperature, humidity and liquid profiles using a neural network retrieval method. During post-processing, profiles were also retrieved using one-dimensional variational (1DVAR) methods that combine radiometer observations and model-based (forward-modeled analysis) brightness temperatures. Neural network and 1DVAR retrievals were compared with 6-hr radiosonde thermodynamic (temperature and humidity) soundings to 10-km height during weather conditions including rain, wet snow and snow. The comparison demonstrated radiosonde-1DVAR agreement to better than standard radiosonde assimilation observation error. Liquid profiles from radiometer retrievals, model analysis and estimates from radiosondes will be compared and their relative strengths and limitations will be discussed. High correlation was found

between the appearance of liquid, precipitation and southwest winds. This is consistent with up-valley advection and lifting of moist maritime air, resulting in liquid condensation. Overall, the radiometer 1DVAR retrievals provided continuous temperature and humidity profiles with radiosonde-equivalent assimilation accuracy to 10-km height during all weather conditions.

2B1.1 ID:4730 INVITED/INVITÉ 10:30

The high-resolution numerical weather prediction system for the 2010 Vancouver Olympics

Jocelyn Mailhot [1], *Bertrand Denis* [2], *Amin Erfani* [2], *Andre Giguere* [2], *Anna Glazer* [1], *Neil Mclennan* [2], *Ron McTaggart-Cowan* [1], *Jason Milbrandt* [1], *George Isaac* [3], *Paul Joe* [3]
[1] Recherche en prevision numerique / MRD
[2] Development Section / CMC
[3] Cloud Physics Research Section / MRD
Contact: jocelyn.mailhot@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 high-resolution models and the operational 15-km regional GEM model, together with the special SNOW-V10 systems. 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.

1B0.1 ID:4731 INVITED/INVITÉ 11:00

Multi-year objective analyses and assimilation of surface observations

Richard Menard [1], *Alain Robichaud* [1], *Yulia Zeitseva* [2], *Yan Yang* [1]
[1] Air Quality ResearchDivision /Environment Canada
[2] Canadian Meteorological Center/Environment Canada
Contact: Richard.Menard@ec.gc.ca

We have developed over the years a multi-year analysis of surface ozone and PM2.5 of the AirNOW over North America data using CHRONOS and nowadays GEM-MACH. Several aspects of the implementation and specification of the analysis solver and implementation are discussed, and in particular how does it differ from typical objective analyses of meteorological fields. How are observations error variances specified. What is the implication of error of representativeness in a surface objective analysis scheme? What is the structure of the structure of the background error covariances, and should they be the same to perform objective analyses in contrast to perform assimilations. What correlation models best fit the innovations ? – Is there a theoretical justification of it ? Can we formulate an analysis solver that minimizes the assumptions or its impact that are usually made in their implementation such as assuming that the background error variance has a zonal

structure? We also examined what are the typical temporal, vertical, and horizontal correlation length scales of air quality model and its implication on the observation network density. Finally we examine the value of these analyses not only to improve forecast but also to evaluate model errors, to detect multiyear trends

3C4.3 ID:4732 14:15

Heat, salt and volume conservation in the N. Pacific

Howard Freeland
Institute of Ocean Sciences, Sidney, B.C., Canada, V8L 4B2
Contact: howard.freeland@dfo-mpo.gc.ca

The N.E. Pacific has been well-populated with Argo floats now for about 8 years with sufficient density of coverage to allow computation of dynamic height over the entire region. This talk will show results from a detailed examination of the transport of water, heat and salt into and out of a large control volume established in the N.E. Pacific. The transport of each of these is horizontally divergent and this allows monitoring of the vertical velocity at the base of the layer and the advection of heat and salt through the base of the control volume.

The vertical velocity estimated by this method is rather larger than the historically expected vertical velocity, so detailed tests are described that allow an assessment of the consistency of this estimate of a large vertical velocity.

4C3.5 ID:4733 14:30

Resonant generation of internal waves by short length scale topography

Marek Stastna
University of Waterloo
Contact: mmstastn@uwaterloo.ca

We consider the resonant generation of internal waves by small-amplitude topography with multiple local maxima. We demonstrate that for near-critical inflows the initial resonant generation process is locked to the topography. However, the process undergoes a profound reorganization in the long time limit, and yields waves with an amplitude that is larger than the theoretical maximum for waves far upstream. For subcritical flows, we demonstrate that short length-scale topography can successfully generate nonlinear short, mode-1 waves with an upstream directed group speed, but that these are generally confined to the region over and downstream of the topography. We demonstrate that, due to the inherently shorter length scale of higher mode waves, subcritical flows over short topography can generate mode-2 waves even for stratifications well removed from the mid-depth. Finally, we discuss the implications of our results to slowly changing currents such as tides.

3B5.4 ID:4734 11:15

Trends and Variability in the Start of the Outdoor Skating Season in Canada

Nikolay Damyanov [1], *Damon Matthews* [2], *Lawrence Mysak* [3]
[1] Department of Atmospheric and Oceanic Sciences, McGill University
[2] Department of Geography, Planning and Environment, and GEC3, Concordia University

[3] Department of Atmospheric and Oceanic Sciences, and GEC3, McGill University
Contact: nikolay.damyanov@mail.mcgill.ca

Climate change affects a range of human activities, including one of Canada's prime sources of entertainment: ice skating. Whether done recreationally or as hockey, its outdoor component is heavily dependent on weather. Based on communication with officials from various Canadian cities, we have established a meteorological criterion for the initiation of an outdoor skating season (OSS) as the last day in a sequence of the first three consecutive fall/winter days with a maximum temperature below -5 °C. Using this filter, we have extracted the start date of the OSS for each year during the fifty-five year period 1951-2005 from a comprehensive daily temperature dataset (Vincent et al., 2002). For each station, a time series of the OSS start has been created and the magnitude, sign and statistical significance of the slope of the respective best-fit line determined. In order to establish a relationship of the OSS with large-scale climate patterns, stations are grouped into six climatic regions. Each region is then tested for correlation in a composite analysis with the Pacific North-American Oscillation (PNA) and the North Atlantic Oscillation (NAO). Currently, an attempt is made at isolating the signal from these climate indices in order to determine how much of the variability is caused by them. The primary results of the study indicate that most stations in British Columbia and southwest Alberta, as well as the southern Ontario/Quebec region have witnessed a progressively later onset of the OSS over time. The Prairies, northwest Canada, and some Maritime locales observe the opposite trend, although magnitudes are smaller. Significance tests on the regression lines show that most of these trends are not significant at the 95% level. However, the OSS starts in western Canada exhibit very good correlation with PNA patterns, while the eastern OSS starts are well connected with the NAO.

2D6.5 ID:4735 17:15

What controls the erosion of the cold intermediate layer in the Gulf of St. Lawrence?

Frédéric Cyr [1], *Daniel Bourgault* [1], *Peter S. Galbraith* [2]
[1] Institut des Sciences de la Mer, Université du Québec à Rimouski
[2] Ministère des Pêches et Océans, Institut Maurice-Lamontagne
Contact: frederic.cyr@uqar.qc.ca

Cold intermediate layers (CIL) are common features in many subarctic and mid-latitude marginal seas. These water masses are generally produced during the winter season as surface mixed layers caused by atmospheric cooling and windstorm mixing events. The newly formed cold surface layer becomes a CIL when sandwiched between the deep layer from oceanic origin and a new warmer surface mixed layer that appears at the onset of spring. Considering the Gulf of St. Lawrence as a study case, we examine the summer erosion of its CIL based on 17 years of historical CTD measurements and new microstructure measurements collected at an offshore station. The analysis suggests that the local turbulence during calm summer days is too weak to explain the CIL erosion rate. Various other mechanisms such as boundary mixing at hot spots (e.g. Sills), sporadic windstorms, or other transient phenomena (e.g. baroclinic instabilities) are now examined to account for the unobserved mixing sources. A back-of-the-envelope calculation suggests that windstorms are ineffective at eroding the CIL. A field campaign was designed in summer 2010 to examine boundary mixing. These new observations will be presented along with a discussion on the role of boundary mixing in CIL erosion.

2D2.5 ID:4736 17:00

Windshield efficacy at the NOAA/FAA/NCAR winter precipitation testbed

John Kochendorfer [1], *Mark Hall* [1], *Scott Landolt* [2], *Steve Cristanelli* [2], *Roy Rasmussen* [2], *Tilden Meyers* [1], *Bruce Baker* [1]
[1] ATDD/NOAA
[2] NCAR
Contact: john.kochendorfer@noaa.gov

Although precipitation is an important fundamental meteorological variable, wintertime precipitation measurement is beset with significant errors. At the NOAA/FAA/NCAR winter precipitation testbed in Marshall, CO an intercomparison of methodologies used to measure winter precipitation is ongoing. As part of the research performed at the testbed, liquid equivalent snowfall measurements from weighing precipitation gauges within different windshields were compared. Measurements from the Geonor weighing precipitation gauge (T-200B) recorded simultaneously within 6 different types of windshield indicate that a new, Belfort double Alter shield shows significant improvement in catch efficiency over the traditional double Alter windshield due to a decrease in porosity from 50% to 30%. In most events the Belfort double Alter measurements compared well to double-fence intercomparison reference shield (DFIR) and small (2/3 size) DFIR (SDFIR) measurements. Using the (S)DFIR measurements as a standard, catch efficiencies from the traditional single and double Alter shields, the Belfort single Alter shield, and an unshielded gauge decreased significantly with wind speed.

4C0.2 ID:4737 13:45

Millennial-scale impacts of marine biogenic calcification perturbation on ocean carbon cycling

Andrew Pinsonneault [1], *Damon Matthews* [1], *Eric Galbraith* [2]
[1] Concordia University
[2] McGill University
Contact: andr_pin@live.concordia.ca

Ocean acidification and increases in sea surface temperature resulting from increasing anthropogenic carbon dioxide emissions are likely to impact calcification rates in numerous pelagic organisms which may, in turn, lead to changes in both ecosystem structure and the ocean's capacity to uptake and sequester carbon. However, the responses of pelagic calcifying organisms to acidification and warming driven changes vary widely between different strains and species leading to a degree of uncertainty in predicting the future fate of anthropogenic carbon dioxide (CO2) and climate change. Here we address this uncertainty by incorporating a dependence of calcite production on calcite saturation state in the University of Victoria Earth System Climate model, an intermediate complexity coupled carbon-climate model, and examining the changes in global ocean carbon cycling following both "business as usual" and "mitigation" CO2 emissions scenarios. Preliminary results indicate that considering a dependence of sea surface calcite production on saturation state leads to as much as a 24.2% decrease in global calcite production rates. This results in changes to sediment, ocean, and atmospheric carbon pools of 31.3 PgC, 35.2 PgC ,and 43.1 PgC respectively at the year 5000. These results suggest that response of pelagic calcifying organisms to anthropogenically-driven changes in ocean saturation state can have an important influence on biological carbon cycling in the ocean, leading to changes in the partitioning of carbon between the ocean and atmosphere on millennial timescales.

2D4.3 ID:4738 16:45

Seasonal flow variability in the straits connecting Prince William Sound to the Gulf of Alaska

Mark Halverson

Prince William Sound Science Center
Contact: mhalverson@pwssc.org

Results from a five year oceanographic mooring program to monitor the exchange of water between Prince William Sound and the northern Gulf of Alaska are presented. Prince William Sound is a semi-enclosed sea which has two substantial connections to the Gulf of Alaska: Hinchinbrook Entrance and Montague Strait. The exchange of water through these passages is thought to have a significant impact on the circulation and biology of the sound. The observations consist of four subsurface moorings (two per passage) equipped with current profilers and conductivity/temperature sensors. The mooring design and sampling characteristics are a substantial improvement over past efforts because of the length of the deployments, and because they provided some horizontal flow information.

In this talk, observations from two deployments representing summer (April 2009 – October 2009) and winter (November 2009 – April 2010) conditions are used to emphasize the seasonal variability in sub-tidal flow through the passages. In summer, western Montague Strait is characterized by a weak outflow over the full water column, and the eastern strait is characterized by a stronger inflow which is both surface and bottom-intensified. In winter, the western strait outflow strengthens and becomes surface intensified, while a surface outflow develops along the east side. The flow through Hinchinbrook Entrance is much different. For example, the deep summer inflow occurs along the western side instead of the eastern side. In winter, the deep western inflow disappears, and both sides are characterised by westward flow at all depths with little vertical shear. The difference between the two entrances is likely caused, to some degree, by differences in their bathymetry.

2C4.3 ID:4739 14:30

3D Numerical Modeling of Flows and Sediment Transport for Tidal Current Turbines in Canoe Pass, British Columbia

Jianhua Jiang [1], *David Fissel* [2]
[1] ASL Environmental Sciences Inc
[2] ASL Environmental Sciences Inc.
Contact: dfissel@aslenv.com

The 3D coastal circulation numerical model COCIRM-SED was recently adapted and optimized to investigate the water flows and sediment transport associated with installing and operating the underwater turbines in Canoe Pass, where the causeway dam, being in place since the 1940’s, is planned to be completely removed and replaced by two underwater turbine systems for electricity generation. The COCIRM-SED finite difference numerical model was operated at very high resolution horizontal grid scales of 10 and 50 m to examine the differences in the flow regime and sediment transport patterns between the present situation with the causeway and creating openings in the causeway for the turbine units. In the extreme case situation as in the scenario of having both turbine units removed for service, regarding sediment transport and the impact on the surrounding area flows, the numerical modeling was conducted with flows being unimpeded through duct openings in the barrage. In this case the installation flow resistance is minimal resulting in the highest level of flows between the two basins on either side of the barrage. The detailed model results of flows and sediment transport were used to examine such regimes and potential issues associated with the underwater turbines as (1) effects on navigation in Seymour Narrows due to altered current flows and current jets; (2) effects on the HMCS Columbia dive site due to silt transport and altered current flows; (3) effects on the Yellow Island Aquaculture Facility due to silt transport and altered current flows and current jets; (4) Canoe Pass flow rate; (5) sediment transport characteristics on either side of Canoe Pass in both Seymour Narrows and the bay to the east of Canoe Pass including the dive site and the Yellow Island Aquaculture Facility.

2D3.6 ID:4741 17:15

Parameterizations of Relative Humidity and Cirrus Cloud Formation from CloudSat and ACE for GCM Model Comparisons

Wayne Evans
NorthWest Research Associates
Contact: wayne@mesosphere.net

The problem of cirrus formation is key to evaluating the contribution of aviation to global warming. Contrail cirrus clouds and cirrus generated from contrails are the most important components of the radiative forcing contribution. Cirrus is measured with the CloudSat and Calipso satellites. Subvisual cirrus are measured with OSIRIS instrument on ODIN. Relative humidity is measured with ACE satellite from FTS water vapor combined with ACE temperatures. Preliminary data from these satellites is used to demonstrate the type of results expected from this investigation. Cloud presence plots of the frequency of occurrence of cirrus cloud versus relative humidity will be used to investigate cirrus formation and in particular the thermodynamic relationships and mechanisms. This data could be applied to determine the formation areas of cirrus for aviation climate change studies. Cirrus formation models in GCMs will be tested by simulating these plots. A set of cloud presence formation plots can be derived from GCM global data maps; CCGCM3 will be used as an example. The formation plot equations can then be used to compute global cirrus maps from relative humidity maps. This information would be extremely valuable for use with future relative humidity mapping satellites and use in global warming models to quantify the aircraft contrail contribution to global warming.

4D1.5 ID:4742 16:45

Chaos in Regional Climate Model simulations: Budget diagnostics of internal variability

Oumarou Nikiema , *René Laprise*
ESCER - UQAM
Contact: nikiema@sca.uqam.ca

It is well known that, in chaotic systems, repeated predictions launched with even minute differences in initial conditions will eventually diverge from one another. Hence deterministic predictions have finite validity time horizons. External forcings and boundary conditions exert some control on the trajectory in phase space: hence the forced components of the Earth System do not suffer from predictability time limitation. This is what permits climate-change projections under altered conditions, such as increased greenhouse gases resulting from the fossil fuel burning. While chaos limits weather forecasts, it is in fact exploited in climate projections. Ensemble simulations from several models, and several runs of each model launched from slightly different initial conditions, are pooled together. Due to the ergodicity property of Global Earth System simulations, the statistical robustness of the climate-change signals and accurate determination of rare events can be improved either with longer simulations or with more numerous shorter simulations. This is only possible due to the chaotic nature of the Earth System. Hence chaos contributes to order. The situation is quite different in nested Regional Climate Models (RCM) simulations because lateral boundary conditions applied around the limited-area computational domain exert some control over RCM simulations. Internal Variability (IV) is generally smaller than Time Variability (TV) in RCM simulations, and hence RCM simulations do not satisfy the ergodicity property as do GCM simulations. A detailed diagnostic budget study of IV reveals the physical processes responsible for the maintenance and time

variations of IV in RCM simulations. The results confirm that IV arises in RCM simulations from the chaotic nature of the governing field equations.

3B5.2 ID:4743 10:45

Modelling spatial variations in energy budgets of humans exercising in outdoor urban recreational parks and spaces

Jennifer Vanos , *Graham Slater* , *Terry Gillespie* , *Natasha Kenny* , *Jon Warland* , *Robert Brown*
(Presented by *Jenni Vanos*)
University of Guelph
Contact: vanosj@uoguelph.ca

With the resounding threats of climate change and the amplified growth of urban regions, urban heat islands (UHI) are becoming an increasingly prominent topic in the literature. Research and assessments into quantifying exposure to excessively warm weather in various energy situations are becoming considerably relevant to urban health and quality of life. Urban and recreational planning must incorporate the use of bioclimatic design in order to provide suitable spaces for exercise, which can increase the number of people using outdoor urban areas, while benefiting human health and society as a whole. The current study applied the COMFA energy budget outdoor model to simulate and spatially analyze the thermal comfort of users exercising in four outdoor parks in Toronto, Canada. This is a direct example of how a thermo- physical based numerical model can link the outdoor climate–human relationship with design of neighbourhoods and recreational parks. Urban parks have the ability to decrease human energy budgets - moreso in heat stress situations; however, incorporation of large trees within parks to block radiant energy are deemed the most vital aspect to lower dangerously high budget levels. Furthermore, relatively small urban parks, such as those used within the current study, result in insignificant cooling extension from the park to surrounding streets. With the number of extreme heat days and population age increasing, heat may remain as the most dangerous weather-related killer, particularly in climatic diverse regions. Further research is warranted to assess the geographical extent of temperature and budget cooling potentials with respect to size and tree cover. The ultimate goal is allow a model, such as COMFA, to be applied with a small number of variables that are readily available to landscape architects, thereby allowing them to easily determine the thermal comfort, cooling potential and UHI mitigation of their designs.

4D6.6 ID:4744 16:45

The Integral Fast Reactor (IFR): An Optimized Source for Global Energy Needs

Charles Archambeau [1], *Randolph Ware* [2], *Tom Blees* [1], *Barry Brook* [3], *Yoon Chang* [4], *Jerome Peterson* [5], *Robert Serafin* [6], *Joseph Shuster* [1], *Evgeny Velikhov* [7], *Tom Wigley* [8]
[1] Science Council for Global Initiatives
[2] NCAR, CIRES (US)
[3] University of Adelaide (Australia)
[4] Argonne National Laboratory (US)
[5] University of Colorado (US)
[6] NCAR (US)
[7] Kurchatov Institute (Russia)
[8] NCAR, University of Adelaide (Australia)
Contact: ware@radiometrics.com

The new Generation IV nuclear power reactor (the IFR, "Integral Fast Reactor") can provide the required power to rapidly replace coal burning power plants and thereby sharply reduce greenhouse gas emissions, while also replacing all fossil fuel sources within 30 years. We conclude that this can be done with a combination of renewable energy sources, IFR nuclear power and ordinary conservation measures. We summarize the design and functionality of the primary component of this mix of sources, namely the IFR nuclear system, since its exposure to the scientific community and public at large has been limited. We consider the cost of replacing fossil fuels while utilizing renewable and nuclear sources to generate electricity, as well as the cost of meeting increasing national and global demand for electrical power. The amount of IFR fuel available is sufficient to supply world-wide needs for many hundreds of years without Uranium mining.

Basic IFR features:

• Closed-cycle IFR nuclear reactors extract 99% of the energy in Uranium fuel, whereas current reactors extract only 1%;

• IFR produces relatively small amounts radioactive waste with less than 300 yr toxicity, compared to much larger amounts of waste with toxicity periods >300,000 yr) produced by current nuclear power systems;

• An electrochemical "pyroprocessor" can be integrated with a fast reactor (FR) in a closed process that separates "spent" FR fuel into "fission product" waste and the new isotope fuel to be cycled back into the FR;

• This recycling process can be repeated until 99% of the original Uranium energy is converted to electrical power;

• Pyroprocessing does not separate out the fissile isotopes that could ostensibly be used for nuclear weapons (these are mixed with the minor actinides and trace fission products), thereby producing no useful material for would be proliferators;

• If metal IFR fuel overheats for any reason, it expands and reduces its density and terminates the chain reaction, automatically shutting down the reactor -- an important passive safety feature.

2C3.2 ID:4745 14:15

Validation Prospects of Aerosols Properties for the Future GCOM-C/SGLI Satellite

Jules R. Dim [1], *Tamio Takamura* [2], *Pradeep Kathri* [2], *Hiroshi Murakami* [1], *Takahashi Y. Nakajima* [3]
[1] EORC/JAXA, Japan
[2] CEReS/Chiba University, Japan
[3] Tokai University, Japan
Contact: dimjules.rostand@jaxa.jp

In preparation of the satellite derived products for the future polar orbiter, the Global Change Observation Mission –Climate (GCOM) carrying the Second Generation GLobal Imager (SGLI) sensor, a validation study on aerosols properties (optical thickness and the Ångström exponent) observed by actual satellites, is conducted. The satellites chosen for this study, Terra-MODIS and Aqua-MODIS, have comparable radiometric and geometric characteristics to the GCOM-C/SGLI. The validation data are daily aerosols observations (for a period of three years) above three radiation sites located in the southern part of Japan. The quality of the satellite data is evaluated and an assessment of

their accuracy is presented. The satellite derived aerosols properties are generally close to the in-situ data with however a positive bias in comparison to the latter for the aerosols optical thickness, while the Ångström exponent shows lower values (dominance of coarser particles) and consequently a negative bias. The impact of the quality of the aerosols size distribution model used in the retrieval algorithms and the contamination due to the presence/proximity of clouds to the aerosols observation areas, are examined to explain the differences between the satellites and the in-situ results.

2B3.3 ID:4746 11:00

Assessing the possibility of AQHI forecasting using GEM-MACH15 prediction tendency

Qian Li , *Fraser Dametto*
Atmospheric Science and Applications Unit , MSC Operations - Ontario, Environment Canada
Contact: Qian.Li@ec.gc.ca

A performance evaluation of GEM-MACH15 predictions for Ozone (O3), Nitrogen Dioxide (NO2) and fine particulate matter (PM2.5) indicated that the model has some substantial systematic bias in estimating the PM2.5 and NO2 levels for sites in Southern Ontario. On the other hand, the model demonstrated its capability to capture short- and long-term temporal trends of pollutants. To maximize the use of the model forecast products, a tendency study has been carried out using observations and model outputs collected over 14 sites in Ontario for December 2009 – November 2010. The purpose of this study is to assess whether the model's mean and maximum forecast tendency over a 24-hour window (Day2 - Day1) would add value to the raw model forecast guidance, or if it would introduce extra noise instead. A potential forecast tool from this study, that combines real-time measurements with the model 24-hour tendency, would be easy to implement, yet helpful to the forecasters. In addition, understanding the spatial variability of model performance in tendency forecasting between urban and sub-urban/rural locations could potentially help build the program capacity for future expansion to rural areas.

2B1.2 ID:4747 11:00

Integrating NWP Forecasts and Observation Data for Nowcasting over Complex Terrain

Laura Huang [1], *George Isaac* [1], *Grant Sheng* [2]
[1] Environment Canada
[2] York University
Contact: laura.huang@ec.gc.ca

Nowcasting, or short range forecasting (0-6 hours), over complex terrain with a high degree of accuracy is very desirable but also very challenging. A weighting, evaluation, bias correction and integration system (WEBIS) for generating nowcasts by integrating NWP (numerical weather prediction) forecasts and high frequency observations has been developed and tested during the Vancouver 2010 Olympic and Paralympic Winter Games. Three NWP models of the Canadian GEM (Global Environmental Multi-scale) regional (spatial resolution of 15 km) and LAM (Limited Area Modeling, spatial resolution of 1 km and 2.5 km) models were selected for generating the integrated nowcasts (INTW). Eight weather forecast variables including temperature, relative humidity, wind speed, wind direction, gust, visibility, ceiling and precipitation rate were nowcasted. Through the verification of forecasts from INTW and NWP models among 15 sites, it is found that the integrated model produced much more statistically accurate results for the selected forecast variables. The INTW improvements are consistent regardless of selected variables and locations. The percentages of improvement are statistically very significant for temperature, relative humidity, wind speed and gust.

In this paper, the key techniques to integrate NWP models and observation are described. Some verification results of INTW are also presented.

2B0.1 ID:4748 10:30

The METAREA Initiative – A Governmental Focus on the Arctic

Marie-France Gauthier
National Services Operations Division, Weather and Environmental Prediction and Services Directorate
Contact: Marie-France.Gauthier@ec.gc.ca

The Arctic Ocean is undergoing a significant physical transformation as a result of changing environmental conditions including earlier and longer opening of the various waterways such as the Canadian Northwest Passage, the occurrence of large fractures in the middle of the winter sea ice pack and formation of polynyas where previously there had been solid ice. Ice has seasonal effects on weather and climate, on marine ecosystems, on safety and efficiency of marine transportation and on oil/gas and mineral activities. With the significant decrease in the extent of Arctic sea ice since 1990, and with a record minimum extent of 4.3 million square kilometres recorded in 2007, Arctic shipping volume is expected to rise steeply in the coming years. In recognition of the potential for significant increases in Arctic shipping and therefore an increase in the likelihood of shipping accidents that can put human lives and the integrity of the Arctic marine environment at risk, the International Marine Organization (IMO) is expanding the Global Maritime Distress and Safety System (GMDSS) Maritime Safety Information service to the North Pole through the implementation of five new Meteorological/Navigational (MET/NAV) areas. In 2007, with formal approval from the Minister of Fisheries and Oceans and the Deputy Minister of the Environment, Canadian officials informed the international community of Canada's willingness to take on METAREA responsibilities for two new Arctic areas. In summer 2010, Environment Canada's Meteorological Service receives a $26 million dollars over a five year period from Treasury Board to develop and implement "The METAREA Initiative". This talk will describe the METAREA Initiative along with a discussion on expected benefits for Canadians, project implementation plan and progress made so far.

3C6.4 ID:4749 14:15

PNA Predictability at various time scales

Waqar Younas , *Youmin Tang*
Environmental Science and Engineering, University of Northern British Columbia, Canada
Contact: vickyqau@gmail.com

The predictability of Pacific North American (PNA) is studied on time scales from days to seasons using ensemble predictions of four dynamical models and information-based measures of predictability, including predictive information (PI), predictive power (PP) and Relative Entropy (RE). It is found that the predictability increases as the time scale of average increases from days to weeks and to months. The PI and PP, dominated by ensemble spread, are more important than the RE, a combination of ensemble spread and ensemble signal (amplitude), in quantifying the PNA predictability. Further analysis found that, unlike ENSO predictability, the dispersion component dominates the signal component in RE measures of PNA for all lead times and over all time scales from days to seasons which biases the relationship of RE to overall prediction skill.

2C6.6 ID:4751 15:15

Structure and variances of equatorial zonal circulations in a multimodel ensemble

Bin Yu [1], *Francis Zwiers* [2], *George Boer* [3], *Mingfang Ting* [4]
[1] CRD, Environment Canada
[2] Pacific Climate Impacts Consortium, University of Victoria
[3] CCCma, Environment Canada
[4] Lamont-Doherty Earth Observatory, Columbia University
Contact: bin.yu@ec.gc.ca

Structure and variances of the equatorial zonal circulation, characterized by the atmospheric mass flux, are examined and inter-compared in results from 12 IPCC-AR4 coupled climate models with multiple ensemble members and from the NCEP-NCAR and ERA-40 reanalyses. The climate model simulations analyzed here include integrations of the 20th Century simulation (20C3M) and the 21st Century simulation using the SRESA1B scenario. We examine the structure of equatorial zonal circulations and the associated tropical diabatic heating, internal and forced variances of the circulations, and changes of the circulations with the external forcing. The relative agreement of the results between the climate models and the reanalyses and the agreement between individual models are evaluated, based on second-order space-time climate difference statistics.

2D3.3 ID:4752 16:30

Hindcast of clouds, precipitation and climate with CanAM4

Knut Von Salzen , *Jason Cole* , *John Scinocca* , *Jiangnan Li* , *Norman Mcfarlane* , *Cathy Reader* , *Mike Lazare* , *Larry Solheim*
CCCma, Environment Canada
Contact: knut.vonsalzen@ec.gc.ca

The latest version of the Canadian Centre for Climate Modelling and Analysis Atmospheric Global Climate Model (CanAM4) includes several new parameterizations for clouds and radiation. To test these improvements, simulations were performed for the time period 1950-2009 using specified sea surface temperatures in CanAM4. Model results were compared to newly available observations of precipitation and radiative fluxes at the top of the atmosphere. In order to further investigate the role of clouds in climate, correlations between cloud radiative effects and precipitation with sea surface temperatures, vertical velocity and lower tropospheric stability were also considered. Results from the comparisons give evidence for an overall realistic representation of dynamic and thermodynamic influences on clouds in CanAM4, especially in comparison to results from several other global climate models. Systematic biases were identified that are probably related to the representation of convection in CanAM4.

2B0.3 ID:4753 11:00

An Operational Automated Sea Ice Analysis System

Thomas Carrieres , *Mark Buehner* , *Lynn Pogson* , *Alain Caya* , *Paul Pestieau*
Environment Canada
Contact: tom.carrieres@ec.gc.ca

A system for preparing automated sea ice analyses has recently been implemented at the Canadian Meteorological Centre. The system uses a 3D variational approach to assimilate ice chart, passive microwave and ocean surface temperatures in combination with a simple persistence model. A

number of quality control techniques have been devised to handle spurious observations. A fairly extensive verification of the system has demonstrated that it is more skillful than existing systems for its initial operational applications. While the system outputs are currently limited to ice concentration and a confidence variable, developments are underway to include more observation types and analysis and forecast variables. The existing system and verifications will be described as well as plans for future developments.

4D6.5 ID:4754 16:30

High-Resolution Hydrometeorological Modeling for the Prediction of a Significant Reservoir Inflow Event

Dominique Bourdin [1], *Roland Stull* [1], *Doug Mccollor* [2]
[1] University of British Columbia
[2] BC Hydro Corporation
Contact: dbourdin@eos.ubc.ca

High-resolution numerical weather prediction (NWP) models have the potential to increase the accuracy of precipitation forecasts, especially in regions of complex terrain. This spatially heterogeneous meteorological information is particularly important in hydrologic forecasting using distributed watershed models. Such forecasts are important for the safe and economic management of hydroelectric reservoirs. To this end, three NWP models run on nested grids of 12, 4 and 1.3 km grid spacing have been used to drive the distributed WATFLOOD hydrologic model. The various modeling systems have been evaluated for a significant inflow event to a hydroelectric reservoir in the mountainous terrain of southwest British Columbia, Canada. All models show skill relative to persistence at all lead times, and can be rated as successful with respect to this event. Surprisingly, for each NWP model, verification statistics generally show a drop in model performance with increasing model resolution. This is likely a side-effect of calibrating WATFLOOD with sparse observations. Since differences in forecast performance metrics vary across the suite of models, it is suggested that most, if not all, would contribute skill to an ensemble inflow forecast. Operationally feasible methods for the calibration of probabilistic inflow forecasts based on such an ensemble are suggested.

3P410.3 ID:4755 15:30

A tool for evaluating climate change impacts at the forest stand level.

Craig Delong [1], *Bruce Rogers* [2], *Hardy Griesbauer* [3], *Craig Nitschke* [4]
[1] University of Northern BC
[2] Ministry of Natural Resources Management
[3] Consultant
[4] Univ. of Melbourne and Univ. of BC
Contact: sdelong@unbc.ca

Drought is one of the leading causes of forest mortality related to climate change. We have developed a tool to predict relative risk of stand-level tree species mortality from drought and drought-induced insect attack. Within climatically homogenous areas, we use current and predicted future climate data, along with modal site and soil conditions for ecosystem units, to calculate actual (AET) and potential evapotranspiration (PET) for these units. Knowledge of tree species drought tolerance limits, which can be expressed by AET/PET, can then be used to develop tree mortality risk maps using forest cover and ecosystem unit maps as input layers in a GIS. Risk related to tree mortality agents that are enhanced by drought (e.g., bark beetle species) can also be mapped based on ecosystem-specific AET/PET values and tree species and age of forest cover polygons. The accuracy of the maps are

being tested with field data and remote sensing (e.g., Normalized Difference Vegetation Index) outputs. The tool we have developed can be used to map the risk of drought-related mortality at a relatively fine scale for any plant species with well established drought tolerances. This tool thus provides information at an appropriate scale to guide operational forest management adaptation to climate change and also complements other tools such as large-scale bioclimate envelope models.

4B1.3 ID:4756 11:15

Medium-Range Ensemble Forecast Verification for Users in the Energy Sector

Dominique Bourdin [1], *Katelyn Wells* [1], *Doug Mccollor* [2], *Roland Stull* [1]
[1] University of British Columbia
[2] BC Hydro Corporation
Contact: dbourdin@eos.ubc.ca

Forecast verification is an essential part of the forecasting process, allowing modelers and users alike to assess the skill and utility of forecast model output. Diversity in the user community alone is such that verification methods useful for one small set of users may not be useful to another. There is a need for the development of verification tools for specific users through the cooperation of forecast providers and the users that they serve. A custom suite of forecast products and verification tools has been developed to meet the needs of BC Hydro's weather forecast program. Medium-range deterministic forecast accuracy, bias, and association products are updated daily based on the past 30 days of forecasts and verifying observations. The 42- member NAEFS ensemble is evaluated on a yearly basis using the rank histogram, reliability diagram, the Relative Operating Characteristics (ROC) diagram, and numerical measures such as the Continuous Ranked Probability Score (CRPS) and Brier Scores and their respective decompositions. The full suite of performance metrics is available to the user via a website designed specifically to meet their operational needs. Recent errors are a valuable tool in the daily forecasting procedure, as they allow the users of the forecasts to make adjustments to the forecasts where necessary. The yearly verification sets will be useful in comparing the performance of various forecast post-processing schemes, as well as for the justification of further investments in such work.

1C2.1 ID:4757 14:00

Complications Regarding Automated Snowfall Measurements—2010 Winter Olympics

Bill Scott
Environment Canada,
Contact: bill.scott@ec.gc.ca

Most of the outdoor venues for the 2010 Vancouver Winter Olympics were held in the Whistler area. This area was historically very data sparce and typically has excessive heavy, wet coastal snowfalls that can exceed the capabilities of common automated sensor systems. Several sensors had be be modified through trial and error, support structures had to be custom designed and datalogger programs needed to be customized to ensure that accurate precipitation related data could be transmitted in 15 minute intervals. During the Olympics, it was a requirement for forecast updates every 15 minutes and therefore it was deemed important to supply accurate ground truthing for verification. It quickly became evident that the design of standard 'snowfall measuring' equipment is generally designed for dry, light interior snow and not for the sticky wet snow to be anticipated along the West Coast Mountains.

3C1.6 ID:4758 14:45

Updating probabilistic weather forecasts using recent observations

Thomas Nipen , *Roland Stull*
University of British Columbia
Contact: tnipen@eos.ubc.ca

Probabilistic forecasts provide a quantitative measure of forecast uncertainty to its user. However, as new observations become available after the forecast is issued, the uncertainty information in the short-term can be adjusted such that the forecasts are sharper and more useful. We present a statistical post-processing method for improving probabilistic forecasts of continuous weather variables given recent observations.

The method models the time-sequence of cumulative distribution function (CDF) values corresponding to the observation as a Markov process. Verifying CDF values are highly correlated in time, and we model their change in time probabilistically by a transition function. The effect is that the spread of the probabilistic forecasts for the first few hours after an observation has been made is considerably narrower than the original forecast. The updated probability distributions widen back towards the original forecast for forecast times far in the future.

The method is tested on probabilistic forecasts produced by an operational system. The method improves the ignorance score of the probabilistic forecast significantly for the first few hours after an observation has been made. The root mean squared error of the median of the probabilistic distribution is also shown to be improved.

2D6.4 ID:4759 17:00

Vertical propagating internal waves generated by a sheared turbulent layer

James Munroe
Memorial University of Newfoundland
Contact: jmunroe@mun.ca

A series of laboratory experiments is presented that model the generation of non-hydrostatic internal gravity waves by the forcing of wind driven turbulent eddies in the surface mixed layer of the ocean. A turbulent shear layer is forced by a conveyor belt affixed with flat plates near the surface of a stratified fluid and downward propagating internal waves are generated. The turbulence in the shear layer is characterized using particle image velocimetry to measure the kinetic energy. The internal waves are measured using synthetic schlieren to determine the amplitudes, frequencies, and the energy of the generated waves. Numerical simulations are used to validate and extend the results of laboratory experiments. This talk will address the question of what fraction of the turbulent kinetic energy of a shear turbulent mixed layer is radiated away by internal waves.

3C3.3 ID:4760 14:00

Coral reefs in a warming world: Lessons from the Central Equatorial Pacific

Simon Donner [1], *Scott Heron* [2], *Toaea Beiateuea* [3], *Aranteiti Tekiau* [3], *Jessica Carilli* [4]

[1] University of British Columbia
[2] NOAA Cora Reef Watch
[3] Government of Kiribati
[4] Australian Nuclear Science and Technology Organization
Contact: simon.donner@ubc.ca

Coral reefs are thought to be more sensitive to climate change than any other marine ecosystem. Sea surface temperatures (SST) of only 1-2 °C can lead the phenomena known as coral bleaching, a loss of colour from the reef-building animals due to a breakdown of the symbiosis with the dinoflagellate Symbiodinium which reside in coral tissue. Occurrences of mass coral bleaching and associated coral mortality around the world over the past three decades have been attributed to rising ocean temperatures. Projected ocean warming over the next three to four decades may make mass coral bleaching a frequent occurrence on most reefs worldwide, depending on assumptions about acclimation and adaptation. Identifying regions and habitats resilient to thermal stress is critical to helping coral reef ecosystems persist in a warming world.

This presentation will examine the impact of past temperature experience on the sensitivity of coral reef ecosystems to present and projected future thermal stress. Evidence will be taken ongoing biological and geological observations in the Central Pacific nation of Kiribati, as well as global climate modeling and historical data analysis. The coral reefs of the little-known island nation of Kiribati experience the highest inter-annual SST variability of any coral reefs in the tropics due to the El Nino / Southern Oscillation (ENSO). The recent increase in "Central Pacific" ENSO events makes Kiribati an ideal natural laboratory for evaluating the impact of frequent thermal stress on coral community structure and the design of resilient marine protected areas.

2D3.2 ID:4761 16:15

Statistical analysis of an LES trade-cumulus cloud field

Jordan Dawe , *Philip Austin*
Department of Earth and Ocean Sciences, University of British Columbia
Contact: jdawe@eos.ubc.ca

An algorithm is presented that allows the automated tracking of all clouds in an LES model simulation. This is used to calculate statistical distributions of cloud properties in a trade-wind cumulus cloud field. Combined with a technique to directly calculate mass entrainment into and detrainment out of individual clouds, we generate entrainment and detrainment probability distributions and examine their variability with respect to other cloud properties.

2D1.5 ID:4762 17:15

Support to Environmental Emergencies at the Meteorological Service of Canada

Nicole Bois On Behalf Of René Servranckx , *Dov Bensimon* , *Alain Malo*
(Presented by *Nicole Bois*)
Meteorological Service of Canada
Contact: rene.sevranckx@ec.gc.ca

Environmental emergencies that result from unplanned, uncontrolled or accidental release of hazardous substances in the air and water cover a wide range of geographical scales (few meters to hundreds or more kilometres) and time scales (minutes to weeks). Environment Canada provides support and expertise for such events when requested by local / regional / provincial authorities or

when federal regulations and lands are threatened or impacted.

The Regional Environmental Emergency Coordinators (REEC) and Teams (REET) call upon the Meteorological Service of Canada (MSC) for the provision of weather support. Depending on the nature of the emergency, this will include one or more of the following: 1) the deployment of an emergency weather station by the EC Region to the incident site; 2) the provision of specialized site specific forecasts (winds, temperature, precipitation, etc.) by EC Regional Storm Prediction Centres, and when toxic / hazardous cloud are involved 3) atmospheric transport and dispersion modelling from EC's environmental emergency response group at the Canadian Meteorological Centre.

To ensure a quick and efficient response, well defined operational procedures / forms are used by MSC for requesting services and for the provision of modelling support. An example of the support provided for a real event is presented.

4C3.2 ID:4763 13:45

The generation of submesoscale dynamics in wind-driven gyres

Francis Poulin
University of Waterloo
Contact: fpoulin@uwaterloo.ca

The winds are responsible for the generation of Western Boundary Currents (WBCs) throughout the world's oceans such as the Gulf Stream and the Kuroshio. These energetic currents generate vortical motions on the mesoscale, O(100 km), that are crucial in mixing and transporting physical and biological properties throughout the ocean. The ocean has a multitude of smaller scale processes that can extract energy from the large-scales and thereby create a direct energy cascade from the mesoscale, to the next smaller length-scale, the submesoscale, O(10 km). The dynamics on this length-scale is quasi-three-dimensional, composed of both vortical and filament-like structures and cascades an abundance of energy to smaller length-scales where viscosity can eventually act to dissipate it.

Any model of WBC formation requires a dissipative force at the western boundary that can extract energy in the basin to balance the vorticity added by the atmospheric winds. The two most famous examples are due to Henry Stommel (1948) and Walter Munk (1950). These, as well as other models, can produce large-scale gyre dynamics that are qualitatively correct. However, they all share the same short coming in that it is unclear how to pick the strength of the parameterizations in a consistent fashion. Indeed, it is very surprising that even today there is no dynamical theory that explains the origin of WBCs without making ad hoc assumptions. In this talk I will present current research that aims to unveil some of the mysteries behind the formation of western intensification in ocean basins. In particular, through a series of numerical simulations of the Rotating Shallow Water equations with various resolutions we quantify the transient motions that are generated and as well compute the energy spectrum of the equilibrated state.

2B4.1 ID:4764 INVITED/INVITÉ 10:30

Climate change, mean sea level and high tides in the Bay of Fundy

David Greenberg [1], *Wade Blanchard* [2], *Bruce Smith* [2], *Elaine Barrow* [3]
[1] DFO Bedford Institute of Oceanography
[2] Dalhousie University

[3] Adjunct Professor, University of Regina
Contact: greenbergd@mar.dfo-mpo.gc.ca

Even without considering meteorological forcing, tidal high water levels can vary in time both from changing mean sea level and from changing tides. We illustrate here that in the Bay of Fundy and Gulf of Maine the two are related. An analysis of long term sea level records shows that independent of climate change, sea level and tidal range are increasing in this system. Our numerical model investigation indicates that current changes in sea level, attributed to post glacial rebound, are giving rise to increasing tides. The combined effects of present day sea level rise, climate induced sea level rise, and the expanded tidal range they induce, will produce a significant increase in the high water level, much greater than that found when considering climate induced sea level changes in isolation. We are predicting a dramatic increase in the risk of flooding at higher high water over the 21st century.

2D5.4 ID:4765 17:00

Effect of sedimentary denitrification on near-bottom oxygen concentrations

Laura Bianucci [1], *Ken Denman* [2], *Katja Fennel* [1]
[1] Department of Oceanography, Dalhousie University, Halifax, NS, Canada
[2] VENUS, School of Earth and Ocean Sciences, University of Victoria, Victoria, BC, Canada
Contact: laura.bianucci@dal.ca

Although diagenetic processes are usually ignored or over-simplified in numerical models, the sediment-water interface plays an important role in the biogeochemistry of continental shelf waters. The anaerobic processes taking place within sediments affect the nutrient fluxes between sediments and bottom waters over the shelf. For instance, previous studies in the Middle Atlantic Bight and the North Sea showed that sedimentary denitrification increases alkalinity (i.e., buffering the carbonate system by decreasing pCO2). Furthermore, by consuming nitrate and producing inert dinitrogen gas (or nitrous oxide), denitrification within the sediments alters the concentration of bio-available nitrogen in shelf waters. Subsequent changes in primary production and nitrification lead to an indirect effect of sedimentary denitrification on oxygen concentrations in the water column. Using biogeochemical model simulations for two sites, Vancouver Island and the Middle Atlantic Bight, we will discuss this effect for the bottom waters of both shelves. We find that denitrification within the sediments can either increase or decrease near-bottom oxygen concentrations depending on the depth of the shelf and the external input of nutrients.

1P306.4 ID:4766 16:00

Modelling the continental shelf of Atlantic Canada

Laura Bianucci , *Katja Fennel*
Department of Oceanography, Dalhousie University, Halifax, NS, Canada
Contact: laura.bianucci@dal.ca

The Ocean Tracking Network (OTN) is an international programme led by Dalhousie University that will implement new technologies and infrastructure to understand changing marine ecosystems across Canada and the global ocean. Within OTN marine animals over a range of trophic levels, ranging from small fish to marine mammals, will be tagged in order to observe their migrations. At the same time, observations of physical, biological, and chemical ocean conditions will be made from ships, moorings and ocean gliders. This will allow an assessment of how migration patterns might be

affected by the changing physical, biological, and chemical conditions of the marine environment. Data-assimilative numerical models will be implemented to provide high-resolution, multi-year hindcasts of currents and biochemical conditions in key locations. Specifically, we are developing a high-resolution, three-dimensional application of the Regional Ocean Modelling System (ROMS) for the continental shelf of Atlantic Canada south of Labrador. The model will include biogeochemical and sea-ice modules, and will use data assimilation techniques to take advantage of the observations generated by OTN. Preliminary model results will be discussed.

3B3.1 ID:4767 10:30

Risk-Based Climate Change Science in Canada's Three Oceans

Paul Lyon
Fisheries and Oceans Canada
Contact: Paul.Lyon@dfo-mpo.gc.ca

Fisheries and Oceans Canada has developed a risk-based profile of areas of greatest risk to the Department from climate change. In response to this risk profile, science research priorities were identified that focus on ecosystem impacts and vulnerabilities, regional coupled climate model development, and significant analysis of two emerging issues: ocean acidification and hypoxia. This presentation will highlight the progress on these science priority areas, based on the past three years of efforts, and present possible future science directions.

1B6.5 ID:4768 12:00

Occurrence of deep convective events under a changing climate using CRCM simulations.

Dominique Paquin , *Ramon De Elia*
Ouranos
Contact: paquin.dominique@ouranos.ca

Severe thunderstorms have an important societal and economical impact and some studies have indicated that their intensity may increase over the century as a consequence of climate change. The objective of our study is to investigate this hypothesis using data produced by the Canadian Regional Climate Model (CRCM) version 4. The first part of the study concentrates on establishing a link between CAPE, wind shear and the convective precipitation produced by the model. These parameters may be used to discriminate severe thunderstorms from less severe events. In order to accomplish this, we analyse CRCM simulations driven by ERA-interim reanalysis. The second part of the study concentrates on studying the evolution during the XXI century of deep convective events. For this purpose, outputs from the CRCM driven by different GCMs for present and future climate projections are used. The presentation will show results from this research, it will relate the to previous studies and discuss possible future activities in the area.

1P201.5 ID:4769 16:00

Assessing the relationships between ice crystal mass and particle cross-section area using 2D-C and 2D-P probe measurements

Zlatko Vukovic , *Ismail Gultepe*

MSC
Contact: zlatko.vukovic@ec.gc.ca

Abstract: The objective of this work is to assess the effect of ice crystal habit on mass (M) - particle cross-section area (PCA) relationships. Density (ρi) of ice crystals can change as a function of PCA, shape and size. This affects the calculation of ice water content (IWC) and extinction coefficient through the use of mass-PCA relationships. Ice crystal mass is usually calculated using a mass-maximum diameter relationship for each habit. The relationships developed in the past between ice particle mass and diameter included a wide range of ice particle habits but PCA is very often neglected. The relationship between M and PCA is important for IWC calculations because ice crystal habits are usually not spherical and their shapes range from a column to a complicated aggregate structure. In this work, observations representing 30-second time intervals obtained from 2D-C, 2D-P, and the Droplet Measurement Technologies (DMT) CSI (Cloud Spectrometer Impactor) probes were used in the analysis. These instruments were mounted on the National Research Council of Canada Convair-580 aircraft during the Indirect and Semi-Direct Aerosol Campaign (ISDAC) project, which took place over the Department Of Energy (DOE) North Slope Alaska (NSA) site during April 2008..Four habit categories were considered in the ice particle shape classification including circular, needle, dendrite, and irregular particles. For each habit, the PCA parameter was used to estimate IWC, and then, it was compared with the DMT CSI IWC which may be underestimated due to its sensitivity to small ice crystals. Also, a relationship between IWC and a parameter that is function of PCA and effective diameter (Deff) is developed. In the presentation, various issues related to extinction coefficient, reflectivity, and precipitation rates, and cloud mass will be discussed based on the new mass-PCA relationships and compared to earlier studies.

1P602.5 ID:4770 16:00

The End of Storm Chasing? Detection Probabilities for Spatially Dense Networks From First-Order Nearest-Neighbour Distributions For Newtwork Design.

Christopher Hampel
Environment Canada
Contact: christopher.hampel@ec.gc.ca

For the purposes of risk analysis and network characterization, it would be useful to have a simple method to measure the ability of a network of ground-based weather stations to detect weather events of different sizes. In this work, I describe how the cumulative distribution of First-Order Nearest-Neighbour (NN) distances for a network of non-random, spatially distributed point stations can be used to estimate the distribution of minimum event-detection probabilities for that network. The probability determined by the Nearest-Neighbour method provides a lower-bound or ‘worst-case’ estimate of the probability of event detection by assuming the worst possible event geometry for detection (circular) and no time-evolution or motion of the event (i.e., the statistics are properly stationary). I apply the method to analyze the minimum detection probability distributions for a selection of surface detection networks in Canada and investigate how this probabilistic approach can form the foundation for future network risk analysis.

1C2.6 ID:4771 15:15

One Good Measurement is worth a Thousand Expert Opinions: The Role of Metrology in Meteorology.

Christopher Hampel

Environment Canada
Contact: christopher.hampel@ec.gc.ca

In meteorological monitoring, we rely on accurate, reliable instruments to measure critical atmospheric variables such as temperature and air pressure. These instruments are calibrated according to accepted practices in accredited facilities that ensure traceability to national and international standards. What is often overlooked in the day to day business of measurement; however, is the engineering artistry and scientific insight behind the development of these standards. The science of measurement is the purview of the field of metrology and plays a critical role in meteorological measurement and other Earth observation systems.

When one approaches the metrological level of fundamental measurement, the realization of a quantity often relies on the establishment of an identifiable equilibrium state in the apparatus. In fact, the successful identification of the equilibrium state is critical in metrology and anchors the reliability and accuracy of standards in physical laws that provide context to consensus comparisons. Using equilibrium as a connecting theme, I will describe the fascinating and ingenious science behind the standards used nationally for temperature and air pressure in a manner that is accessible to both scientific and non-scientific staff. Based on previous work as a calibration scientist with MSC; I aim to provide attendees with a general understanding and appreciation of the fundamentals of measurement science, and to bridge a gap in background knowledge that can enrich future discussions across disciplines.

2D6.3 ID:4772 16:45

High-order balance in rotating stratified turbulence

Peter Bartello
McGill University
Contact: bartello@math.mcgill.ca

Although much work was done on the robustness of simplified balance equations representing oceanic and atmospheric flows over the past thirty years, most of it involved low-order dynamical systems. In this study numerical simulations of fully developed rotating stratified Boussinesq turbulence are employed, along with nonlinear normal-mode initialisation, to study balance and its breakdown at relatively high Reynolds numbers. It is found that the balanced contribution to the ageostrophic modal amplitudes is self-similar, with a very steep spectrum, when scaled by Ro^2, where Ro is the Rossby number. The contribution from unbalanced motion has a more shallow spectrum and a more complicated behaviour as a function of Ro. However, its total contribution to the energy grows considerably faster than Ro^2 as the Rossby number is increased. The result is the emergence of an unbalanced shallow spectral range at high wavenumbers. If time permits, the relationship between these results and observations of the ocean and atmosphere will be discussed.

2B2.2 ID:4773 10:45

Simplifying Data Requirements for Mean Sea-Level Pressure Calculations in Canada: Reducing Inherent Risks in Current Approaches to The Plateau Correction.

Christopher Hampel
Environment Canada
Contact: christopher.hampel@ec.gc.ca

In Canada, the practice over the last 30 years for determining the plateau correction for new stations has been to apply spatially horizontal searches for nearby neighbour stations from a database of Pre-existing stations and to apply a Cressman weighted average of the plateau functions of the nearby neighbours. There are three important limitations of this method. First, it assumes that nearby neighbours will have similar elevations by virtue of their proximity to the new station. This introduces a significant uncertainty in the determination of plateau corrections for new stations. Second, the computational effort required to execute this method involves spatial averaging, polynomial regression, haversine conversion, and other steps that contribute their own uncertainties in the final result. Third, there is a sense in which the inaccuracies inherent in the concept of this quasi-empirical correction to fictitious air columns may not warrant the difficulties and risks involved in applying, maintaining and transferring the computational knowledge currently required to ensure that future systems are able to apply the correction in the same way.

In this work, I investigate a simple alternative to the current method of applying the plateau correction. In particular, I revisit the original formulation of the correction first proposed by Ferrel in 1886 (and still recommended by the Smithsonian Tables as the appropriate correction), and compare its results for mean-seal level reductions across Canada against results for the current method.

1A0.2 ID:4774 INVITED/INVITÉ 09:45

Satellite remote sensing of global air pollution

Randall Martin
Dalhousie University
Contact: randall.martin@dal.ca

Ground-level pollution monitors remain sparse in many regions of the world. Climate assessments and air quality management are impeded by uncertainty in traditional “bottom-up” emission inventories based on application of emission factors to activity rates. Satellite remote sensing yields a global data source to address these issues. Global numerical modeling plays a critical role in relating these observations to ground-level pollutant concentrations, and to emissions processes. Satellite-based estimates of global long-term average concentrations of fine particulate matter (PM2.5) and of nitrogen dioxide indicate dramatic variation in pollution levels around the world, with implications for global public health. Inverse modeling of satellite observations reveals large trends in Asian emissions, with implications for long- range transport of pollution across the Pacific Ocean. This talk will highlight recent advances in both remote sensing and global modeling, and their application for air pollution studies.

2B3.1 ID:4775 10:30

Advances in Applying Satellite Remote Sensing to the AQHI

Randall Martin , *Aaron Van Donkelaar* , *Lok Lamsal* , *Akhila Padmanabhan*
Dalhousie University
Contact: randall.martin@dal.ca

Satellite remote sensing provides valuable information on pollutant concentrations, especially in regions without ground-based monitors. A numerical model is useful to relate satellite observations of the atmospheric column to ground- level concentrations of interest for health. This talk with discuss recent advances in applying satellite remote sensing for near-real-time estimates of two key species in the AQHI: NO2 and PM2.5.

4C6.1 ID:4776 13:30

British Columbia’s emerging renewable energy landscape – the role of BC Hydro and the weather prediction community

Doug Mccollor
(Presented by *Douglas Mccollor*)
BC Hydro
Contact: doug.mccollor@bchydro.com

BC Hydro plays a leading role in providing the province’s electricity needs, which are expected to grow by 20 to 40 percent over the next 20 years. BC Hydro’s network of heritage hydropower reservoirs will not be enough to meet the provincial goal of electricity self-sufficiency by 2016 if demand continues to grow as projected. One cornerstone of BC’s Clean Energy Act of 2010 is to acquire more electricity from renewable power projects, such as wind and run-of-river hydro. Increasing power production from wind and run-of-river hydro, that have no storage capacity, increases the variability and uncertainty in efficient generation resource planning. The atmospheric science community plays a critical role in providing weather predictions to help energy sector resource managers balance generation and load, buy and sell market-priced power, and meet regulatory, environmental, and societal statutes. Meteorologists at BC Hydro are working closely with atmospheric scientists and hydrologists to improve our knowledge and build efficient resource management tools.

4C3.4 ID:4777 14:15

Three-dimensional simulation of waves generated by crater topography

Nancy Soontiens , *Marek Stastna* , *Michael Waite*
University of Waterloo
Contact: nancy.soontiens@gmail.com

In this work, we consider waves generated by a flow with constant background velocity and buoyancy frequency over crater-like topography. Waves are generated over the crater rims, with a stronger amplitude in the response over the upstream rim. The three-dimensional structure of the waves leads to an amplification over the crater edges. Comparisons with two-dimensional simulations show that waves over the crater edges are an order of magnitude stronger and have a more complicated structure for three-dimensions. In three-dimensional simulations, waves generated at the crater rims can expand outward and downstream, leading to an amplification over the crater edges. Waves are also generated within the crater bowl, however these waves are of shorter wavelength than those found over the crater rims. These waves are generated by an interaction between the cold air within the crater bowl and the warm air forced into the crater by the background wind. Possible implications for dust lifting near craters will be discussed.

4D3.4 ID:4778 16:30

Temperature, precipitation, and lightning modification in the vicinity of the Athabasca oil sands

Daniel Brown [1], *Gerhard Reuter* [1], *Willliam Burrows* [2]
[1] University of Alberta
[2] Environment Canada
Contact: dmbrown1@ualberta.ca

The Athabasca oil sands development in northeast Alberta has disturbed more than 500 square kilometres of land through surface mining and tailings ponds development. We compared temperature and precipitation at a weather station within the oil sands development with the temperature and precipitation at a weather station away from the oil sands over the past 17 years. We also compared lightning in the vicinity of the oil sands with lightning further away from the oil sands for the past 11 years. We found that the oil sands disturbance does not significantly affect lightning or precipitation, but we found that it does significantly affect the temperature regime. Over the past 17 years, the summer daytime high temperatures have decreased about 0.7 °C, while the overnight low temperatures have increased about 1.2 °C. This is consistent with changing the land cover to a lake, and is likely a result of the construction of large tailings ponds.

4D4.3 ID:4779 16:00

Comparison of SAR marine wind with GEM-LAM atmospheric models in the Arctic

Thomas Bergeron , *Monique Bernier* , *Karem Chokmani* , *Gaëtan Lafrance*
INRS
Contact: thomas.bergeron@ete.inrs.ca

Sea wind maps (speed and direction) derived from SAR imagery can be valuable for atmospheric models and wind energy mapping especially in remote areas where meteorological data are scarce. In the present study, 17 RADARSAT-2 images in Fine (8 m spatial resolution, coverage of 625 km2) and Wide mode (25 m resolution, coverage of 22500 km2), in HH and HV polarization have been acquired in the Hudson Strait region, between July 2009 and January 2011. At the same time, GEM-LAM 2.5 Km wind products(speed and direction) have been obtained from the Canadian Meteorological Center. SAR wind speed is computed using CMOD-5 (Hersbach et al, 2007) and Hwang polarization ratio (Hwang et al, 2010). The wind speed is computed with both inputs, 1) SAR local gradient direction and 2) GEM-LAM directions. SAR local gradient algorithm used wind induced streak signatures to retrieve direction (Koch, 2004). This algorithm was run in a fully automatic manner and compared with GEM-LAM directions. Difference between SAR and GEM-LAM wind speeds have been compared for different configurations: wind coming from the coast or toward, transition from land to sea and atmospheric stability. The SAR and GEM-LAM wind speeds were also compared to the nearest met mast located in Quaqtaq. Preliminary results give a root mean square difference of 2.95 m/s. When eliminating six images with the presence of atmospheric front, rain and sea ice, the RMS difference drop down to 2.68 m/s. The large RMS difference seems to be caused by two storm events, wind speed reach maximum peak of 20 m/s with SAR in those events and is 5 m/s lower on GEM-LAM.

1B3.4 ID:4780 11:45

Recent Improvements in Scatterometer Wind Vector Data Assimilation at Environment Canada

Mateusz Reszka , *Robert Tardif* , *Judy St-James* , *Stephane Laroche*
Environment Canada
Contact: mateusz.reszka@ec.gc.ca

Wind information from the Advanced Scatterometer instrument (ASCAT) has been assimilated in Environment Canada's operational global deterministic prediction system since March 2009. ASCAT is a C-band scatterometer on-board the first Meteorological Operational satellite (MetOp-A), operated by EUMETSAT, while the wind retrievals are provided by KNMI. Since the SeaWinds instrument was taken offline in late November 2009, ASCAT has been the only dedicated source of remotely-

sensed surface wind observations ingested operationally. While inclusion of these measurements was previously shown to have a positive impact on forecast skill, this investigation aims to improve the relevant quality-control and assimilation procedures, in order better exploit the information content of this valuable data set. Specifically, improved screening of retrievals contaminated by sea ice has been implemented, and certain artifacts resulting from the thinning algorithm are removed. Ambiguity selection is performed using the forecast model output, instead of simply relying on the KNMI recommendation, and the weight of scatterometer observations relative to the background is increased. Because the retrievals are provided as equivalent-neutral winds whereas the assimilation scheme employs real winds, the operational system applies a simple correction to the wind speed as an additive constant. As part of this study, a new observation operator has been developed to directly take into account the particular stability-dependent properties of equivalent-neutral winds in the evaluation of innovations and in tangent linear and adjoint calculations. The impact of the above modifications is assessed in terms of observation-minus-forecast errors, as well as forecast scores against both radiosondes and analyses.

3C5.2 ID:4781 13:45

Carbon dioxide source/sink distribution in a mountain pine beetle attacked lodgepole pine stand

Carmen Emmel [1], *Eugénie Paul-Limoges* [1], *Rick Ketler* [2], *Andy Black* [3], *Andreas Christen* [1]

[1] Department of Geography/ Atmospheric Science Program, University of British Columbia, Vancouver
[2] Department of Geography/ Faculty of Land and Food Systems, University of British Columbia, Vancouver
[3] Faculty of Land and Food Systems, University of British Columbia, Vancouver
Contact: cemmel@eos.ubc.ca

Disturbance to northern forest ecosystems due to insect attacks may impact not only the microclimate but also regional to global scale carbon (C) cycling by decreasing photosynthetic carbon dioxide (CO_2) uptake and increasing respiratory CO_2 loss. Most recently the epidemic mountain pine beetle (MPB) outbreak in Western Canada has resulted in large-scale impacts on climate and C cycling. Brown (2010) showed that forest stands in the latter stages of MPB attack can remain CO_2 sinks, contrary to expectations, and speculated that this is due to the secondary stand structure consisting of smaller trees, bushes and shrubs in the subcanopy.

In this study, data from an intensive observation period in July and August 2010 were analyzed to determine the distribution of CO_2 sources and sinks in the canopy of an open MPB-affected stand with considerable secondary structure (stand height z_h = 17 m) near Prince George, BC. Eddy covariance systems (EC) consisting of 3-dimensional sonic anemometers and open-path infrared gas (CO_2 and water vapour) analyzers were operated at 7 heights simultaneously over 36 days on a 30-m-tall tower. This arrangement provided a vertical profile of CO_2 flux density, permitting the calculation of the CO_2 source-sink distribution. These EC measurements were complemented by photosynthetic active radiation (PAR) measurements at six heights, which allowed the investigation of the influence of PAR on CO_2 fluxes.

Results indicated that PAR penetrates deep into the canopy with, on average, about 50% reaching the ground level (1-m height). The flux profile showed a flux divergence of CO_2 with substantial daytime uptake below $0.5z_h$, while in the upper canopy there was respiratory loss. This indicates that secondary structure (located in the subcanopy) largely accounted for the CO_2 uptake and underlines the important role of a healthy secondary structure in the carbon balance of a MPB-attacked stand.

2B6.1 ID:4782 INVITED/INVITÉ 10:30

The atmospheric response to moving tropical heat sources

Grant Branstator
NCAR
Contact: branst@ucar.edu

In the past, the realization that ENSO events exert a marked influence on midlatitude interannual variability prompted a substantial research effort to characterize how the atmosphere responds to quasi-stationary tropical heat sources. Here, recognizing the presence of prominent moving tropical precipitation anomalies in nature, we are interested in characterizing the response to heat sources that are time dependent. We use the fluctuation-dissipation theorem, as applied to the behavior of an atmospheric GCM, to do this. Comparison of GCM and associated FDT solutions demonstrates the effectiveness of FDT in reproducing GCM behavior, including the reaction of state variables and functionals of state. This makes it possible to systematically investigate how the response is a function of the time-dependent properties of the source while also capturing and analyzing important feedbacks that a conventional linearization approach would not include.

We find that the strength, structure and geographical extent of the response are strongly dependent on the rate and direction of the heat source's movement. To some degree this dependence can be anticipated by conventional linear theory, but feedbacks from the synoptic eddies must also be taken into account for a more complete analysis. Perhaps surprisingly, qualitatively the role of the eddy feedbacks is not strongly dependent on the properties of the source's movement, apparently because these feedbacks take place on such a fast timescale. Implications of the findings for the Madden-Julian Oscillation are highlighted.

4B6.2 ID:4783 11:00

Contrasting Decadal Predictability Characteristics of Six CGCMs

Grant Branstator , *Haiyan Teng*
NCAR
Contact: branst@ucar.edu

A new component of the next IPCC assessment report will be decadal time-scale predictions in which models are initialized with states based on the observed state of the climate system. Since the climate system is chaotic, there is an inherent limit on the range at which the information in these initial states can have an impact on the skill of the forecasts. In this presentation we measure this limit for six CGCMs from various research centers. We concentrate on the predictability of upper ocean heat content in the two northern basins, and we use two methods that only require long control runs for estimating predictability limits. One method makes use of analogs and the other uses multivariate linear regression. In contrast to the conventional ensemble technique both methods are able to estimate the average predictability characteristics of very many initial states.

When we use relative entropy as a measure of predictability and consider entire basins, we find that on average the effect of initializing a forecast from a specific initial condition can be detected for about a decade, but this limit can vary by as much as a factor of three from one model to another. Furthermore, for a given model, there are variations in predictability of a factor of four at different locations within a basin. The model-to-model variations can be traced to variations in the properties of horizontally propagating disturbances in each model, including prominent modes. Given the large variations in predictability that exist from one model to another, we conclude that a) the predictability characteristics of each model used for decadal predictions must be carefully determined for proper

design and interpretation of forecasts, and b) the scientific community currently does not have a reliable estimate of the decadal predictability characteristics of nature.

3C6.6 ID:4784 14:45

Experimental implementation of Sigma point Kalman filter for an ENSO prediction Model

Manoj Kk Kizhakkeniyil , *Youmin Tang*
Environmental Science and Engineering, University of Northern British Columbia, Prince George
Contact: kizhakk@unbc.ca

Abstract: The main challenge of Sigma Point Kalman filter (SPKF) is its huge computation expense when applied to a high dimensional system. This study focuses on this issue by introducing and implementing a reduced rank sigma point unscented Kalman filter (RRSPUKF) to a realistic El Nino-southern Oscillation (ENSO) prediction model (LDEO5). This is employed using the Singular Value Decomposition (SVD) to factorize the covariance matrix and reduce its rank through truncation. Singular values are used to select the most important sigma points that will influence the evolution of mean and error covariance so that the reduced sigma points can retain the main features of the original sigma points. Emphasis was placed on the experimental implementation of RRSPUKF for the LDEO5 with the assimilation of sea surface temperature (SST) anomalies in this study. Experiments showed that RRSPUKF assimilation system is able to well analyze the phase and intensity of all major ENSO events from 1971 to 2001. The overall analysis skill of SPUKF is compared against that of ensemble square root filter (EnSRF) scheme but the former is more robust than the latter.

1P306.7 ID:4785 16:00

A high-resolution sediment trap study of organic-walled dinoflagellate cyst production and biogenic silica flux in Saanich Inlet (BC, Canada)

Andrea Price , *Vera Pospelova*
School of Earth and Ocean Sciences, University of Victoria, Canada
Contact: pricea@uvic.ca

Dinoflagellate cyst fluxes and assemblage composition were investigated from November 2007 to February 2010 in Patricia Bay, Saanich Inlet (BC, Canada). Samples were collected using a sediment trap deployed at ~97 m water depth. The sampling interval ranged from 0.5 to 19.5 days, allowing for a high-resolution study of dinoflagellate cyst production in relation to measured environmental parameters. Ninety-six samples were collected and a total of 42 dinoflagellate cyst taxa were identified. The dinoflagellate cyst flux was very high and ranged from ~149,000 to ~2,400,000 cysts m^{-2} day^{-1}, with an average of ~777,000 cysts m^{-2} day^{-1}.

Seasonal and interannual variation in cyst assemblage was recorded. It reflects changes in environmental parameters such as sea-surface temperature, sea-surface salinity, solar insolation, river discharge, and biogenic silica flux. Fluxes of cysts produced by autotrophic dinoflagellates, particularly *Spiniferites* spp. and *Spiniferites bentorii*, were greatest during winter. Spring dinoflagellate cyst assemblages were dominated by *Brigantedinium* spp. and *Quinquecuspis concreta*. In summer the assemblages were characterized by an increase of cysts produced by heterotrophic dinoflagellates, in particular by *Echinidinium delicatum*, *Echinidinium* cf. *delicatum*, *Votadinium spinosum* and cysts of *Protoperidinium minutum*. Multivariate statistical analysis performed on the data supports the observed seasonal trends, where winter taxa are associated with low sea-surface temperatures, low salinity, and high Cowichan River discharge, whereas summer taxa are associated with warmer sea-surface temperatures, higher solar insolation and increased biogenic silica flux. The cyst assemblage from nearby surface sediment was shown to be very similar to an annual average sediment trap assemblage.

2D5.1 ID:4786 INVITED/INVITÉ 16:00

Some consequences of declining oxygen in the Subarctic Pacific

Frank Whitney
Fisheries and Oceans Canada
Contact: whitneyf@shaw.ca

The interior waters of the subarctic Pacific have been losing oxygen for at least several decades. Time series data from the last ~25 years shows that nutrients are generally accumulating at Redfield ratios in subsurface oceanic waters, but at ratios skewed by denitrification and perhaps gas hydrate mobilization along the coast. According to prevailing theory, upper ocean stratification brought on by global warming should impoverish the nutrient store of surface layer. However, surprisingly large subsurface nutrient increases appear to be counteracting this outcome.

3C4.2 ID:4787 14:00

Better estimates of the physical properties of seawater in coastal regions

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

The new international standard Thermodynamic Equation of Seawater 2010 (TEOS-10) is formulated to consistently represent all thermodynamic properties of IAPSO Standard Seawater as a function of a new salinity variable, the Absolute Salinity. The Absolute Salinity is a true mass fraction measured on the Reference Composition Salinity Scale, and can be estimated using measurements of electrical conductivity. However, the relative chemical composition of real seawater differs from that of Standard Seawater. This occurs in the open ocean because of biogeochemical processes, and in coastal areas because of the influence of river salts. In turn, the relationship between conductivity and salinity as well as between salinity and thermodynamic properties like density will also differ. These differences have been quantified by direct measurement in a few cases. After I developed a numerical model that could quantify these changes for more general cases, Dan Wright led the way in adapting the results of open-ocean calculations using this model into the conceptual framework underlying TEOS-10. This effort resulted in the definition of multiple types of 'salinity'. Here I will describe the numerical differences between these different definitions in several coastal regions, and propose a general procedure allowing the use of TEOS-10 for high-accuracy estimates of seawater properties in coastal areas.

4B5.4 ID:4788 11:15

Seasonal cycle of multi-frequency acoustic backscatter in the water column of Barkley Sound, British Columbia

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

In fall of 2009 an upward-looking multi-frequency (38, 123, and 210 kHz) echo sounder was deployed at a depth of 95m in the mouth of Barkley Sound, British Columbia, as part of the Folger Passage NEPTUNE node. Pinging at a rate of 1Hz it has now produced about 1 Tb of data. Preliminary analysis shows a) bubble penetration below the surface to depths of as much as 10m during periods of high winds, b) apparent bubble release from fish, c) wave orbital motions down to 50m d) diel and seasonal variations in fish abundance and schooling behavior, e) diel migration of zooplankton, and seasonal variations in their behavior, d) vertical displacements by internal wave activity d) a variety of other unexplained features. In conjunction with other measurements, echo sounder data thus has the potential to be an important part of any long-term monitoring program.

1B4.4 ID:4789 11:45

Double-diffusive instabilities in the relic seawater of meromictic Powell Lake, B.C.?

Rich Pawlowicz [1], *Esther Gies* [1], *Debby Ianson* [2], *Adrian Jones* [1]
[1] University of British Columbia
[2] Institute of Ocean Sciences
Contact: rich@eos.ubc.ca

Approximately 11000 years ago coastal uplift converted a fjord on the British Columbia coast into the 60km long Powell Lake. The lake's surface, now about 50m above sealevel, is extremely fresh, with very low salinities typical of rain and snow-fed BC coastal lakes, but in two basins relic seawater remains trapped near the bottom. Although molecular diffusion has removed almost half of the salt even at 350m, and the relative composition of the remainder is slightly different than that of present-day seawater, enough dissolved material remains to keep the lake permanently stratified (and anoxic) below 125m. However, temperatures at the bottom are higher than at mid-depth due to geothermal heating, giving a background profile susceptible to double-diffusive instabilities. Temperature and conductivity profiles obtained in 2009 and 2010 show a regular series of steps about 5m high, somewhat reminiscent of those arising from double-diffusive instabilities. However, precise measurements indicate that the water column is stratified even inside these steps. Further analysis is complicated by the extremely high levels of dissolved gases, which can affect density.

4C2.1 ID:4790 INVITED/INVITÉ 13:30

Comparative extended validation of statistical and dynamical downscaling models

Radan Huth [1], *Jiri Miksovsky* [2], *Petr Stepanek* [3]
[1] Institute of Atmospheric Physics
[2] Dept. of Meteorology and Environment Protection, Charles University
[3] Czech Hydrometeorological Institute
Contact: huth@ufa.cas.cz

Two approaches have been massively used to downscale information from large to regional or local scales: statistical and dynamical. However, the two kinds of models have only rarely been validated against a common set of criteria. Moreover, in validation of dynamical models, relatively little attention has been paid to criteria potentially relevant for impacts, such as a temporal and spatial structure of downscaled variables, higher-order statistical moments, extremes, long-term trends, etc. This contribution attempts to at least partly fill this gap in our knowledge. We validate temperature,

precipitation, and relative humidity, simulated by two dynamical and five statistical models over a domain in central Europe with a dense station network. We present results for spatial and temporal autocorrelations, skewness, kurtosis, extreme quantiles, and long-term trends. We conclude that the performance of both downscaling approaches is comparable; none of the downscaling methods can be considered superior; and finally we recommend that the validation should be conducted on a seasonal, not annual, basis.

1B3.2 ID:4791 11:15

Effects of variations in solar activity on modes of low-frequency circulation variability in the Pacific / North American extratropics

Radan Huth
Institute of Atmospheric Physics
Contact: huth@ufa.cas.cz

We describe the effect the 11-year solar cycle exerts on tropospheric circulation in the Pacific / North American domain in winter. Atmospheric circulation is characterized by modes of low-frequency variability and teleconnectivity of 500 hPa heights. We conduct separate analyses for months with low, moderate, and high solar activity. The Pacific / North American pattern (PNA), and especially its Florida centre, weakens under high solar activity; the Tropical / Northern Hemispheric pattern (TNH) vanishes under high solar activity, whereas the East Pacific mode (EP) disappears under low solar activity. The teleconnectivity changes only a little between solar minima and maxima over the North Pacific and North America, which is different from the European / North Atlantic sector where teleconnectivity gets much stronger in solar maxima. We also discuss the interaction of solar effects with the phase of the quasi-biennial oscillation. A separate analysis for the Arctic Oscillation shows that its Pacific centre vanishes under moderate solar activity.

3P501.1 ID:4792 15:30

Impact of Band-Ratio Enhanced SAR Image for Sea Ice Types Discrimination

Nicolas Thai Nguyen
Environment Canada - Canadian Ice Service
Contact: nicolas.nguyen@ec.gc.ca

Differentiating between Arctic sea ice types during the summer break-up and the fall freeze-up using SAR images is a complex task. Microwave signatures respond quickly to the meteorologically induced melt and freeze cycles of snow and ice surfaces. Consequently, the near-surface physical properties of different sea ice types are sufficiently alike that their backscattering characteristics are almost identical. As Canada’s leading source of ice information, the Canadian Ice Service has been investigating the potential of image transformation using a band-ratio of RADARSAT-2 dual-polarization (HH-HV) image products to improve the identification of different Arctic sea ice types. Colour composite images, based on HH, HV, and HV/HH ratio, were generated and evaluated for their potential in discriminating thin sea ice, first-year sea ice, multi-year sea ice, and open water in the Western Canadian Arctic.

1C3.3 ID:4793 14:30

Modelling the seasonal and inter-annual variations of water transport and sea-ice in the Canadian Arctic Archipelago

Shannon Nudds [1], *Ji Lei* [1], *Youyu Lu* [1], *Frederic Dupont* [2], *Charles Hannah* [1], *Simon Prinsenberg* [1]
[1] Fisheries and Ocean Canada
[2] Environment Canada
Contact: Shannon.Nudds@dfo-mpo.gc.ca

In order to understand the seasonal and inter-annual variations of transport through the Canadian Arctic Archipelago (CAA), results of simulations using the Nucleus for European Modelling of the Ocean (NEMO) model are analyzed. Simulations for the period of 1998-2007 are carried out using a 6 km CAA domain nested within an 18 km pan-Arctic model. Results are compared to available mooring and satellite data to validate both the ocean circulation and sea-ice components of the simulations. In addition, results from a global data assimilation reanalysis obtained from Mercator-Ocean of France are analyzed. Both models are able to reproduce a significant part of the observed variability of transport through Barrow Strait, which is mostly related to wind-driven dynamics. The model results also suggest that the mean transport through Barrow Strait is influenced by the transport through Bering Strait.

2D0.3 ID:4794 16:30

Long-Range Ice Forecast System at CIS – An Operational Method

Luc Desjardins [1], *Bea Alt* [2], *Tivy Adrienne* [3], *Tom Carrieres* [1]
[1] Canadian Ice Service
[2] Balanced Environments Associates
[3] International Arctic Research Center, University of Alaska-Fairbanks
Contact: Luc.Desjardins@ec.gc.ca

In 2008, the Canadian Ice Service started to evaluate the usefulness of a Multiple Linear Regression (MLR) approach to forecast the date of occurrence for certain events in the Arctic waters. This approach is based on the ability, defined by using correlation, of certain predictors to forecast certain events (predictands) from a vast pool of Meteorological and Oceanographic data. These predictors range from scalar values such as station freezing degree days or the Arctic Oscillation, to predictand-specific indices derived from gridded climate data (e.g. sea surface temperature, sea level pressure).

This presentation will describe how the Canadian Ice Service produced their Arctic Seasonal Outlook in the past and how this new (MLR) methodology is gradually evolving. Strengths and weaknesses of both approaches will be addressed.

1P602.4 ID:4795 16:00

The role of Prairie and Northern in the installation and maintenance of Environment Canada's Atmospheric Monitoring Networks

Ted Gresiuk
Environment Canada
Contact: darren.tessmer@ec.gc.ca

Prairie and Northern Atmospheric Monitoring Section provides a variety of functions for the Meteorological Service of Canada's atmospheric monitoring networks. This includes installation, repair and maintenance services for networks such as Surface Weather, Upper Air, Radar, Marine as well as support for specialized data networks including Ozone, Solar Radiation and others. 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

2C2.1 ID:4796 INVITED/INVITÉ 14:00

Status of the Polar Communications and Weather (PCW) mission

Louis Garand [1], *Alexander P. Trishchenko* [2]
[1] Environnement Canada
[2] Canada Center for Remote Sensing
Contact: louis.garand@ec.gc.ca

The status of the Polar Communications and Weather (PCW) mission is described. PCW aims at providing by 2017 continuous meteorological, communications and space weather services over the circumpolar domain 55-90 N. This can be accomplished from a constellation of two satellites in a highly elliptical orbit. PCW has completed its phase A with an extensive description of key aspects of the mission: payload design, ground segment, space segment, concept of operations, product generation and distribution. PCW is a high priority mission for the Canadian Space Agency, Environment Canada, the Department of National Defense, and it will involve many other departments. The exact orbit is not yet settled, but at present the science team is favoring one with a 16-h period. This orbital period leads to three apogees separated by 120 degrees in longitude. It benefits from a more favorable environment than the classical 12-h orbit considered in Phase A. The main meteorological payload is an advanced imager with 21 channels covering the spectral range 0.45-14.5 μm. Other science instruments are being proposed by the university sector, notably for air quality and aurora imaging. The presentation will describe the numerous services provided by the mission, with main focus on those related to meteorology. The meteorological component will necessitate the creation of a PCW data processing center with initial staff of order 75 people. PCW represents a new mandate for Canada in Earth Observation. This mandate will engage in various ways a significant portion of the atmospheric community in Canada.

3C4.4 ID:4797 14:30

Rossby Waves and Current Bands in the Northeast Pacific

Michael W. Stacey , *Shawn M. Donohue*
Royal Military College of Canada
Contact: stacey-m@rmc.ca

A numerical model, the Parallel Ocean Program, with 0.25 degree horizontal, spatial resolution and 28 vertical levels is used to simulate the circulation of the North Pacific Ocean for the time period 1970 to 2006 (not including a ten year spin-up from rest). The model is forced with NCEP (National Centers for Environmental Prediction) winds, surface heat flux and atmospheric pressure. Spectral nudging is used so that model drift of the mean state over the time period of the simulation is prevented, while allowing for the prognostic evolution of the circulation at time scales that are not nudged. The simulation produces a series of zonal current bands in the northeast Pacific that are separated by 300-500 km, a distance consistent with the Rhines scale (the scale at which the 2-D

turbulence cascade tends to be arrested). The observed southward shift in the North Pacific Current in 2002-2003, as calculated from scalar observations, is reproduced by the model but, according to the model, it may not be a shift so much as a change in the relative intensity of two zonal current bands. This banding at the Rhines scale suggests an influence from Rossby waves that are heavily affected by nonlinearities, and evidence is found in the model for Rossby-wave-like behaviour in the northeast Pacific, both for coastally-generated waves and for waves generated away from the coast by the local winds. The waves propagate westward at about 1 cm/s.

4D4.2 ID:4798 15:45

Results From the National SAR Winds Project Forecasters Evaluation

Chris Fogarty
Canadian Hurricane Centre / National Marine Lab
Contact: chris.fogarty@ec.gc.ca

Operational forecasters from various weather offices across Canada have recently participated in a formal evaluation of SAR winds in a real-time setting. The activity, arranged by the CSA-funded National SAR Winds Project, was carried out in an effort to familarize weather forecasters with SAR wind fields over the ocean and to build a case for official operationalization of SAR wind products in Canada. Results and examples of feedback from the evaluation will be presented here.

1B2.1 ID:4799 11:00

How do we maintain sustainable high-quality climate observation networks that can answer the question: How has the climate changed over the past 50 years?

Bruce Baker
NOAA/ATDD
Contact: Bruce.Baker@noaa.gov

As we experience a new era in which the Earth   s climate is forced by human activities, it is critically important to maintain an observing system capable of detecting and documenting global climate variability and change. Policy makers and the general public require climate observations to assess the present state of the ocean, cryosphere, atmosphere, and land, and place them in context with the past. To be of widespread value to scientists and society, these observations must be sustained over many decades and remain of the highest quality. Climate observations are needed to evaluate and initialize climate models and to improve predictions of climate change. Such efforts are essential for guiding national and international policies that govern climate-related resources, and for building agreements aimed at mitigating long-term climate change. Climate researchers have used existing, operational networks because they gave been the best, and sometimes only, source of data available. Guidelines have been developed for climate observing systems, specifically the ten climate monitoring principles. These principles should be considered in the design of new networks.

4D3.2 ID:4800 INVITED/INVITÉ 15:45

Interesting Aspects of the Cobequid Pass Snowstorm / Aspects intéressants de la tempête de neige de Cobequid Pass

Mark Pilon

Meteorological Service of Canada (MSC)
Contact: mark.pilon@ec.gc.ca

On Wednesday Nov. 19, 2008 an unanticipated snowstorm brought 20 cm of snow to central Nova Scotia over a short period of time. Precipitation began as rain but rapidly changed over to heavy snow mid afternoon causing rapidly deteriorating travel conditions. Nearly 1500 motorists travelling on Trans-Canada Highway 104 through the Cobequid Pass became stranded in their vehicles Wednesday night as a result of numerous vehicles becoming stuck and blocking the highway in both directions. An analysis of the structure and evolution of some of the fields associated with this storm using a variety of data sources suggest the impact of this storm can be attributed to the presence of strong upper level dynamics. The resulting large pressure falls, development of a strong low level jet, release of potential instability at mid-levels and significant low level cooling due to melting and evaporation of precipitation and cold air advection appear to have greatly aggravated the impact of the storm. In order for the forecaster to effectively nowcast these rapid and unexpected precipitation phase change-over events the choice of observational data for monitoring current conditions and of the analysis techniques applied to the data can be crucial. In addition unconventional data sources have the potential to be a very useful aid to the forecaster in his or her effort to stay one step ahead of the weather.

Le mercredi 19 novembre 2008 une tempête de neige imprévue apporta 20 cm de neige au centre de la Nouvelle-Écosse sur une courte période de temps. Les précipitations ont commencé sous forme de pluie, mais rapidement ont changé au cours de l'après-midi en neige intense causant une détérioration rapide des conditions routières. Près de 1500 automobilistes circulant sur la route transcanadienne 104 par le col de Cobequid se sont retrouvés bloqués dans leur véhicule dans la nuit de mercredi bloquant ainsi la route dans les deux sens. En utilisant une variété de sources de données, l’analyse de la structure et de l'évolution de certains des champs associés à cette tempête suggère que l'impact de cette tempête peut être attribuée à la présence d'une forte dynamique dans les hauts niveaux. Les fortes chutes de pression qui en ont résulté, le développement d'un fort courtant jet à bas niveaux, le dégagement de l'instabilité potentielle à mi-niveau et le refroidissement significatif dans les bas niveaux dû à la fonte et l'évaporation des précipitations et de l'advection d'air froid semblent avoir contribué à aggraver l'impact de la tempête. Pour que le prévisionniste diagnostique et prévoit à court terme de manière efficace ces événements de rapides changements de phase de la précipitation, le choix des données d'observation pour la surveillance des conditions actuelles et des techniques d'analyse appliquées aux données peut être crucial. De plus, des sources de données non conventionnelles ont le potentiel d'être une aide très utile pour le prévisionniste dans son effort pour garder une longueur d'avance sur le temps.

4B3.5 ID:4801 INVITED/INVITÉ 11:30

High resolution climate forcing of an ice sheet model with a global and regionally nested coupling scheme: Implications for modelling high latitude glacial initiation processes

Guido Vettoretti , *Jonathan Gula* , *Heather Andres* , *Richard Peltier*
University of Toronto
Contact: g.vettoretti@utoronto.ca

The climate impacts that are the result of short timescale cryospheric dynamics have recently been recognized as important climate processes that must be incorporated into the framework of Earth system climate models if we are to fully realize the implications of future climate change scenarios. The latest version of the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM1) allows for one-way coupling with the Glimmer Community Ice Sheet Model (Glimmer-CISM). These new directions in cryospheric research will allow for the modelling of

Greenland Ice Sheet (GIS) mass-balance and future sea level rise under future anthropogenic climate warming. Equally as interesting, is the subject of the expansion and contraction of high altitude mountain glaciers which have experienced significant changes in the past. One area of research that continues to receive attention is the modelling of the processes that lead to the nucleation of the large continental ice sheets which were the dominant features of the climate system during the Late Pleistocene. Here we will present a coupling framework whereby the high- latitude cryospheric system is modelled with Glimmer-CISM mass-balance driven primarily from the Polar Weather Research Model (PolarWRF) which is in turn nested within the NCAR CESM1. Specifically GIS mass balance in the modern epoch and ice accumulation in the Canadian Arctic Archipelago paleoclimate epochs will be presented.

2B1.3 ID:4802 11:15

Evaluation and operational support by the National Laboratory of the Atlantic during the Canada Winter Games in 2011 / Évaluation et support opérationnel par le Laboratoire National de l’Atlantique lors des jeux d’hiver du Canada de 2011

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

The Canada Winter Games in 2011 which took place in Halifax from February 11 to 27 have always been seen as a great opportunity to pass on some of the legacy in terms of models and forecasting tools developed during the games Olympic 2010 in the Atlantic region.

During the congress we will present the project which was developed by the National Laboratory for Marine and Coastal Meteorology to evaluate the Olympian version of LAM2.5km in the Atlantic, to offer minimal service to the Canada Winter Games organization, and if Mother Nature has enabled some cases resulting from this evaluation will be presented

Les jeux d’hiver du Canada de 2011 qui se sont déroulés à Halifax du 11 au 27 février ont toujours été vus comme une belle opportunité de transmettre une partie de l’héritage en matière de modèles et d’outils de prévisions développés lors des jeux olympiques de 2010 dans la région Atlantique.

Lors du congrès, nous présenterons le projet qui fut mis en place par le Laboratoire National pour la Météorologie Marine et Côtière pour évaluer la version olympienne du LAM2.5km dans la région Atlantique, offrir un service minimal à l’organisation des Jeux d’hiver du Canada, et si Dame Nature l’a permis quelques cas résultant de cette évaluation seront présentés.

3P708.1 ID:4803 15:30

A Heavy Rainfall Event Causing Flooding in Northern New Brunswick

Charlotte Gabites
Environment Canada
Contact: charlotte.gabites@ec.gc.ca

Over the five days between July 31st and August 4th, 2008, some parts of northern New Brunswick received more than 200 mm of rain. This was a major rainfall event for northern New Brunswick causing flooding and road washouts. The event started on the afternoon of Thursday, July 31st as a convective outbreak of slow-moving, training thunderstorms. These continued intermittently through the next several days, eventually combining with and enhancing rainfall from a synoptic low pressure system passing south of the province. While the numerical guidance leading up to this event had indications that there could be significant rainfall, there was a lot of uncertainty due to variability between different models and between model runs. Forecasts issued to the public were initially slow to include large rainfall amounts. Warnings were eventually issued for both severe thunderstorms and heavy rainfall, but a greater lead time for the public would have been preferable. This poster will examine what meteorological clues were present beforehand, if any, which might have led to better initial forecasts of this event.

3C6.3 ID:4804 14:00

Seasonal Predictions of East Asian-Western North Pacific Summer Monsoon in the Coupled Models

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: yangdj77@gmail.com

In this study, the predictability of East Asian-Western North Pacific summer monsoon (EA-WNPSM) in the ENSEMBLES stream 2 coupled models is investigated in terms of forecast skill, potential predictability and dominant predictable modes, etc. It is found that model prediction skill of Western North Pacific summer monsoon (WNPSM) is higher than that of East Asian summer monsoon (EASM) and the multimodel ensemble (MME) usually has better prediction skill compared to individual model ensembles. The potential predictability can, to a large extent, explain the geographical distribution of forecast skill. However, it cannot effectively explain the skill improvement of MME compared to individual models. The possible reason for that is also discussed. In addition, the leading predictable patterns of EA-WNPSM are detected using the most predictable component analysis method, and the underlying physics responsible for these predictable patterns is also explored.

3C6.5 ID:4805 14:30

A hybrid ensemble method for Argo data assimilation

Ziwang Deng
UNBC
Contact: ziwang.deng@gmail.com

In the ensemble Kalman filter (EnKF), ensemble size is one of the key factors that significantly affect the performance of the data assimilation system. A relatively small ensemble size has to be chosen in many present EnKF-based assimilation systems due to the limitation of computational resources. This issue is of particular concern in Argo data assimilation where the most complex start-of-the-art models are often used. In this study, we propose a hybrid ensemble method to estimate background error covariance matrix. The hybrid method assumes the statistical properties of the model error do not change significantly at neighbor analysis steps during a short time window, thus allowing the ensemble generated at previous steps to be used at present steps. As such, a joint ensemble matrix combining previous and present steps can be constructed to form a larger hybrid ensemble for estimating the background error covariance. Therefore, this method can enlarge the ensemble size but without extra integration for ensemble members. Further, we apply this hybrid ensemble method to assimilate Argo and altimetry datasets into an oceanic general circulation model. Experiments show

that the use of the hybrid ensemble can improve the performance of the EnKF by reducing the root mean square error, increasing the consistency between different state variables, as well as improving the relationship between root mean square spread and ensemble mean error.

3P706.2 ID:4806 15:30

Application of Spectral Nudging to NPZD-type Models.

Karl Bryan Lagman , *Laura Bianucci* , *Katja Fennel*
Dalhousie University
Contact: karl.bryan.lagman@dal.ca

A spectral nudging technique was proposed by Thompson et al. (Ocean Modelling, 2006, 13:109-125) to reduce model drift and bias in a 3-dimensional physical ocean model. A desirable feature of the spectral nudging technique is that it can preserve high frequency variability that would be dampened with conventional nudging techniques. Here, we apply the spectral nudging method to simple Nitrogen-Phytoplankton-Zooplankton-Detritus (NPZD) models. The models were constructed by combining high frequency nutrient upwelling events (on time scales of days to weeks) with a climatological annual cycle. We assess the effects of spectral nudging and conventional nudging for a test case with biased climatological mean, and demonstrate how spectral nudging allows the model to evolve prognostically outside the frequency bands in which nudging is applied.

2C4.4 ID:4807 14:45

Inferring sediment transport pattern in the Bay of Fundy from tidal velocity fields

Yongsheng Wu , *Jason Chaffey* , *Dave Greenberg* , *Keir Colbo* , *Peter Smith*
Bedford Institute of Oceanography
Contact: Yongsheng.Wu@dfo-mpo.gc.ca

A change in sediment transport is one of the potential environment consequences of the recently proposed tidal power project in Minas Passage. In this study, the patterns of horizontal sediment transport in the upper Bay of Fundy were studied using a 3-D hydrodynamic model. The model was evaluated against independent observations, and showed reasonable agreement with observed tidal levels, tidal currents, residual currents and tidal asymmetry indicators. Using the modelled velocity fields, the patterns of horizontal sediment transport were inferred. The pathways of net sediment transport are dependent on the combination of residual flow and tidal asymmetry. In the areas of Minas Channel, Minas Passage and Minas Basin, the net sediment transport mainly follows the residual flow. However, tidal asymmetry dominates the sediment transport in Cobequid Bay, where stronger flooding tidal currents give rise to the tidal asymmetry.

3C0.4 ID:4808 14:30

Tropospheric and Stratospheric Ozone Changes in the Canadian Middle Atmosphere Model (CMAM) with Tropospheric Chemistry

Mary Catherine Reader [1], *David Plummer* [2], *John Scinocca* [2]
[1] University of Victoria
[2] Canadian Centre for Climate Modelling and Analysis
Contact: mcreader@telus.net

Stratospheric and tropospheric ozone both play an important role in climate and have seen significant changes since preindustrial times due to anthropogenic precursors, ozone depleting substances (ODSs) and climate change. We have performed a suite of time-slice simulations using a version of CMAM with stratospheric and tropospheric (methane-NOx) chemistry designed to partially disentangle these effects on atmospheric ozone and investigate contributions to ozone radiative forcing. These include preindustrial and present-day simulations as well as one with present-day climate and precursor emissions and preindustrial ODS levels. The role of stratospheric and tropospheric changes on the distribution of ozone and the impact of these changes on radiative forcing will be discussed.

3C1.1 ID:4809 13:30

Scribe Nowcasting: Understanding the System

Claude Landry , *Jean-François Deschenes* , *Matthew Holly* , *Linh Chi Nguyen* , *Reine Parent* , *Donald Talbot* , *Jean-Pierre Talbot*
(Presented by *Donald Talbot*)
Centre Météorologique Canadien
Contact: claude.landry@ec.gc.ca

In 2005, the experimental version of an Integrated Nowcasting System (INS) was added to the Scribe forecast production tool used by the operational forecasters in all Canadian Storm Prediction Centers. This system was built to allow forecasters to integrate real-time observed and nowcasting data in their forecast. Although this INS prototype has been available 24/7 over the last few years, its usage by the forecasters is very occasional. During this presentation we will explore what seem to be the main causes that could explain why the INS in not well integrated in the forecast production routine. We will discuss some improvements to the INS interactivity that are planned in the short and medium term and propose what appears to be the main requirement skills that forecasters should have to fully use the data from the INS. We will also present a training strategy aiming to provide a better understanding of the INS by the users. A training plan will be establish in collaboration with the regional Science Transfer and Training (STT) representatives.

3C1.2 ID:4810 13:45

Scribe Nowcasting: Towards Improved Performances

Claude Landry [1], *Mark Alliksaar* [2], *Victor Chung* [2], *Jean-François Deschenes* [1], *Norman Doaldson* [3], *Matthew Holly* [1], *Laura Huang* [3], *George Isaak* [3], *Reine Parent* [1], *Donald Talbot* [1], *Jean-Pierre Talbot* [1]
[1] Centre Météorologique Canadien
[2] National Lab for Nowcasting and Remote Sensing Meteorology.
[3] Cloud Physics and Severe Weather Research Section
Contact: claude.landry@ec.gc.ca

The experimental version of the Integrated Nowcasting System (INS) was implemented in the Scribe forecast production tool in 2005. Since this time, no effort was dedicated to improve the quality and the performances of the forecasted data produced. The observed data currently inputted into the system such as the surface observations, radar imagery and lighting strikes need to be optimised and revised, and new sources of observation should be considered such as satellite diagnostic fields. Similarly, the current short term forecast systems feeding the INS need to be examined and/or replaced by better performing systems such as the ones that were developed by the Cloud Physics and Severe Weather Research Section in Downsview and tested in the CAN-Now and SNOW-V10 projects. Currently these nowcasting systems used in the INS are: MAPLE (McGill Algorithm Precipitation Lagrangien Extrapolation), PubTool (Statistical Nowcast System) and a Lightning extrapolation algorithm. The decision rule system that manages the observed and forecast data provide the deterministic sequence of weather elements. This rule based system will be modified to increase reliability of forecast. Modification will be validated through a new re-structured verification system. The first steps that were undertaken will be presented as well as the work planned for the months to come.

4C0.4 ID:4811 14:15

Biogeochemical Modelling in Canada's High Latitude Oceans

Nadja Steiner [1], *Jim Christian* [1], *Warren Lee* [2], *Ken Denman* [3]
[1] IOS & CCCma - Fisheries and Oceans Canada, Sidney, BC
[2] CCCma - Environment Canada, Victoria, BC
[3] University of Victoria, Victoria, BC
Contact: Nadja.Steiner@ec.gc.ca

Large uncertainties exist regarding the ways in which the biology and biogeochemistry of the Canadian Arctic are responding to climate change. Biogeochemical models can help elucidate these changes, project ecosystem behavior, synthesize observations, and guide resource-limited field campaigns. Models are particularly useful in the Arctic due to limited access and incomplete satellite and field data coverage. To comprehend the impact of climate change on the ecosystem and biogeochemical cycles, modelling based on measures of key processes and a range of in situ validation data are required. Specific questions we need to address are: i) How much of the observed Arctic biogeochemistry can we reproduce in our models? ii) How does the Arctic ecosystem respond to recent and future changes in sea-ice cover and other climate related changes (e.g. acidification, stratification, hypoxia?) iii) How does the ecosystem adapt? vi) How can we link to fisheries and other human interests. v) How do changes in the Arctic biogeochemistry affect the rest of the global ocean? At this point we are not ready to answer these questions, but we are working on the required tools. We will point out the necessary steps towards answering the above questions and present historical simulations and future projections using the Canadian Earth System Model (CanESM). The latter show intensified acidification in Canadian Arctic waters, and limited increases in primary production following ice retreat due to a lack of nutrient availability. Increased stratification and mixed layer shoaling also leads to reduced productivity in currently highly productive areas at the edge of the Arctic.

2B0.5 ID:4812 11:30

Development of a new global sea ice analysis at the Meteorological Service of Canada.

Alain Caya , *Manon Lajoie* , *Mark Buehner* , *Tom Carrieres*
Environnement Canada
Contact: alain.caya@ec.gc.ca

A new automated global sea ice analysis has been developed, primarily for providing sea ice concentration fields for numerical weather prediction models. The analysis is based on a variational approach in which multiple sources of observations are combined to update the previous analysis. The bulk of the observations comes from passive microwave remote sensing data (AMSR-E, SSM/I). A retrieval algorithm (NASA TEAM II) is used to obtain sea ice concentration estimates that are then assimilated together with operational ice charts produced by the Canadian Ice Service (CIS). A higher

resolution regional version of the analysis system was extensively validated against independent CIS ice charts.

The Interactive Multisensor Snow and Ice Mapping System (IMS) product from the US National Ice Center is used as verification data to evaluate both the new global sea ice analysis and the current Canadian operational global sea ice analysis. The impact of additionally assimilating ice concentration retrievals from SSM/IS data using the NASA TEAM algorithm is also investigated.

3B0.3 ID:4813 INVITED/INVITÉ 11:15

Toward understanding the dynamics of stratosphere-troposphere coupling

David Thompson , *Thomas Birner*
Colorado State University
Contact: davet@atmos.colostate.edu

Observations and experiments with numerical models reveal that stratospheric variability has a demonstrable effect on surface weather on a range of timescales. Stratospheric sudden warmings have been linked to changes in precipitation and the incidence of cold-air outbreaks throughout the Northern Hemisphere during winter. The Antarctic ozone hole has been linked to a range of observed climate trends over Antarctica and the Southern Ocean during summer. Here, the physical mechanisms that underlie the observed linkages between stratospheric variability and surface climate are examined in an isentropic framework. The stratospheric mass circulation is found to modify the meridional slope of the isentropes in the troposphere. These modifications in the slope of the tropospheric isentropes in turn lead to changes in lower tropospheric heat fluxes as well as tropopause level momentum fluxes. These changes in eddy fluxes are shown to be consistent with a diffusive model of downgradient eddy fluxes. The results provide novel insights into the physical mechanisms that drive the surface response to sudden stratospheric warmings as well as the surface response to the Antarctic ozone hole.

4B0.6 ID:4814 11:45

Despite changes in C allocation, ecosystem carbon use efficiency is unaltered in temperate forest ecosystems at up to three times current atmospheric carbon dioxide concentrations and drought

Rebecca Trueman [1], *Miquel Gonzalez-Meler* [2]
[1] Concordia University Chicago
[2] University of Illinois at Chicago
Contact: rebecca.trueman@cuchicago.edu

Rising atmospheric carbon dioxide concentrations and corresponding climate change have increased the demand for a better understanding of ecosystem carbon exchange processes. Temperate forests have the potential to sequester C if the stimulation of photosynthesis from elevated carbon dioxide concentrations is greater than increases in the combined respiration of plants and soil. However, understanding and quantifying autotrophic and heterotrophic respiration from soils can be complicated due to the tight linkage between the roots, rhizosphere and heterotrophs. To determine the contribution of soil pools to ecosystem respiration we $^{13}CO_2$ pulse-labeled one day's photosynthate at the beginning, middle and end of the growing season in three forests: a *Liquidambar Styraciflua* forest at Oak Ridge National Laboratory Free Air Carbon dioxide Enrichment Site (ORNL FACE), a *Populus deltoides* plantation at Biosphere 2 Laboratory (B2L), and a tropical rainforest inside B2L. Each of these forests had been grown in unique $^{13}CO_2$ environments at carbon dioxide concentrations ranging

from ambient to three times current carbon dioxide concentration. Using carbon-13 pulse-labeling events we measured ecosystem carbon use efficiency (~NPP/GPP) in situ and partitioned soil respiration into three age classes: heterotrophic respiration from older organic material, heterotrophic respiration of recent organic material and root-rhizosphere respiration. Using this two step stable C-isotope labeling technique we elucidated ecosystem C flow dynamics in two forests under future carbon dioxide concentrations and drought. This study provides evidence of the necessity to examine not just the direct responses of plants and heterotrophs to rising atmospheric carbon dioxide concentrations, but the interactive effect of the two when estimating carbon sequestration potential of forests.

3B5.5 ID:4815 11:30

The 2009 and 2010 forest fires in British Columbia posed a health threat to people most at risk from air pollution – and created a "teachable moment" to inform them about the relationship between air quality and health. Learn how the social media tool Twitter was used to inform people about BC's Air Quality Health Index (www.airhealthbc.ca) and influence their actions – when they needed it most.

Sharon Stevens Apr, Fcprs , *Wendy Heshka Abc*
(Presented by *Sharon Stevens*)
Communication Solutions - www.solutiongroup.ca
Contact: sharon@solutiongroup.ca

During the 2009 and 2010 fire season, Communication Solutions, on behalf of the BC Ministry of Environment, used the social media tool Twitter, to inform people about the Air Quality Health Index (www.airhealthbc.ca) and influence their actions – when they needed it most. As leaders in marketing and communication for outdoor health, responsible for social marketing of the AQHI in British Columbia, we continually address the challenge of making air quality relevant to BC residents who enjoy relatively good air quality, most of the time. The past summer interface forest fires made air quality more relevant for more people -- and BC's AQHI social media program played a prominent role in informing and potentially influencing behavior -- by helping people identify their health risk and encouraging them to activate their personal lung health medical plans. Learn about the results of this program, including 1) Increased awareness of the AQHI, 2) Increased promotion and referrals by 3rd parties, 3) Increases in media inquiries about the AQHI via twitter and 4) Increased visits to the airhealthbc.ca website.

4D6.3 ID:4816 16:00

Numerical studies of tidal power potential.

Roy Walters
O-RM
Contact: rawalters@shaw.ca

Several approaches can be used for estimating tidal power potential. From a theoretical point of view, others have shown that the problem can be reduced to a single or multiple boundary problem with simple geometry where each has a well defined maximum power potential. From a practical point of view, the potential can be approximated from the ambient flow. Questions naturally arise whether the theoretical approach can be applied to a typical field-scale problem, and whether the practical

approach has any validity. In order to provide more insight into these questions, form drag representing tidal turbines has been introduced into a numerical flow model. This is an unstructured grid model with an implicit treatment of wetting and drying that has been shown to be robust, accurate, and efficient for highly irregular coastal ocean environments and is well suited for this problem. The field sites that have been examined are Minas Passage in the Bay of Fundy and the inland waters of coastal British Columbia. They provide an interesting practical perspective for this problem.

2C4.1 ID:4817 INVITED/INVITÉ 14:00

A tsunami generated by a Cascadia subduction zone event, coastal 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, is a multipurpose 3D primitive equation hydrodynamic model that uses a semi-implicit time approximation and uses a finite element (FE) spatial discretization with triangular and quadrilateral elements. 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. Here, we will focus on a new method to treat wetting and drying implicitly, and a method to treat subgrid topographic variation. The accuracy of these methods is evaluated using the runup testcase for a circular basin with parabolic depth variation. Then these methods are applied to a 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, although on a much shorter time-scale.

1P308.4 ID:4818 16:00

Applications of west coast wave buoy data

Johannes Gemmrich
University of Victoria
Contact: gemmrich@uvic.ca

The first routine wave buoy observations off Canada’s west coast started in the late 1970s. This program evolved into an operational network of 13 buoys in the open ocean and on the continental shelf (plus additional buoys in more sheltered areas), reporting hourly observations of the wave field as well as basic meteorological parameters. These data sets are archived at ISDM (DFO Canada) and are of unique value to studies of many wave processes. Three examples of applications of west coast wave buoy data -- rogue wave studies, long term wave trends, and effects of wave-current interaction -- are presented here. These examples also highlight that the rigorous scientific analysis of the archived data requires additional steps of data quality control.

2D4.4 ID:4819 17:00

Observations of long-duration episodic bottom currents in the Middle America Trench: Evidence for tidally initiated turbidity flows

R.e. Thomson [1], *E.e. Davis* [2], *M. Heesemann* [3], *H. Villinger* [4]
[1] Department of Fisheries and Oceans
[2] Geological Survey of Canada
[3] NEPTUNE Canada
[4] University of Bremen
Contact: richard.thomson@dfo-mpo.gc.ca

Benthic flow in the Middle America Trench off the Pacific coast of Costa Rica is examined using time series from a single-point acoustic current meter moored 21 m above bottom at 4386 m depth at the southern end of the trench from November 2005 to April 2007. In addition to significant (~ 0.1 ms-1) tidal currents, the instrument recorded a series of twelve, episodic northwestward along-trench flow events of roughly monthly duration. Event velocities often exceeded 0.25 ms-1 and were contemporary with enhanced acoustic backscatter intensity. Events ended with a rapid (< 1 day) reversal to southeastward flow and reduced backscatter. Seafloor temperature records from two nearby Ocean Drilling Program (ODP) borehole observatory sites reveal that the flow events were accompanied by a steady rise in bottom water temperature. Temperatures dropped abruptly to background values at the end of each event. The event timing generally tracked the envelope of the tidal current modulation. Based on the November 2002 to February 2009 borehole observatory temperature records, the events had a mean duration of 40(±20) days and were separated by a between-event interlude of 30(±25) days. Findings indicate that the episodic flows were likely rotationally modified, autosuspending turbidity currents initiated by tidal current resuspension of sediments above the shoaling trench floor to the southeast of the mooring site. Suspended particles in the turbidity currents are estimated to range from 0.0003 to 0.006% of the current by volume. Results suggest that tidally induced turbidity currents may be common to steep, well-mixed regions of the deep ocean adjacent to sediment rich continental margins.

2D3.4 ID:4820 16:45

Parameterization of Dust Aerosol Optical Properties and Radiative Forcing in CanAM4-PAM

Yiran Peng [1], *Jiangnan Li* [2], *Knut Von Salzen* [2]
[1] University of Victoria
[2] CCCma, Environment Canada
Contact: knut.vonsalzen@ec.gc.ca

Mineral dust is a significant contributor to global aerosol optical depth and radiative forcing. The optical properties are essentially determined by dust mass loading and the size distribution according to Mie theory. Two different types of parameterization for optical properties are studied in this work. The first one uses aerosol mass loadings from simulations with a bulk aerosol model and employs specified mode radius and standard deviation in two prescribed size modes. The other is a continuous scheme, which takes both mass loading and size parameters from microphysical simulation of aerosol size distributions based on the PLA (Piecewise Log-normal Approximation) method. The two schemes are tested with an off-line one dimensional radiative transfer model. Simulation results show that dust radiative forcing is sensitive to column mass loading, size distribution, solar zenith angle and surface albedo. The continuous scheme is in a better agreement with results from a control run with theoretical calculations based on Mie theory. The two schemes are also employed in an experimental version of the fourth generation of the Canadian Atmospheric Global Climate Model with online PLA Aerosol Model (CanAM4-PAM). Simulated global aerosol optical depth and direct aerosol radiative

forcing at the top of atmosphere in CanAM4-PAM agree well with results from other GCMs and satellite observations, when the continuous scheme is applied.

1B2.2 ID:4821 11:15

British Columbia's Climate Related Monitoring Program – A Status Report

E. (ted) J. Weick
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 and road weather forecasting, flood forecasting, irrigation planning, hydro electric generation and for forest ecosystem research programs. Climate change and variability are and will continue to impact public safety programs and hydrologic regimes in all areas of the province. Under the Climate Related Monitoring Program, the Province has partnered with BC Hydro, Rio Tinto Alcan and the Pacific Climate Impacts Consortium to develop common standards and procedures to set the stage for production of a Provincial Climate Data Set utilizing currently existing networks in British Columbia.

This paper represents a report out on the status of the work to date and accomplishments for the Climate Related Monitoring Program.

2C5.4 ID:4822 15:00

Estimating marine nutrient loss from dissolved N_2/Ar measurements

Roberta Hamme [1], *Steven Emerson* [2]
[1] University of Victoria
[2] University of Washington
Contact: rhamme@uvic.ca

The global ocean inventory of nitrogen-based nutrients (fixed-N) is controlled by input from N_2 fixation and by losses from a variety of denitrification pathways that return fixed-N to N_2 gas in suboxic or anoxic environments. New estimates of the rates of these sources and sinks suggest that the nitrogen cycle is grossly out of balance, with the sink potentially outstripping the source by 2-3 times. If true, the oceanic loss of fixed N will eventually impact global productivity levels and export of organic carbon from the surface ocean. Observations of the dissolved N_2/Ar ratio can be used to estimate loss rates from sedimentary denitrification (one of biggest errors in the budget). Our measurements of N_2/Ar in the deep ocean show an increase of 0.5% from the North Atlantic to the North Pacific. These waters are sufficiently oxygenated to prevent fixed-N loss in the water column. However, oxygen concentrations may be drawn down to zero in the first centimetres of the sediment allowing significant rates of denitrification with the resulting N_2 diffusing out of the sediments and into the overlying water. We show that the measured increase in N_2/Ar is consistent with model-based estimates of sedimentary denitrification in the deep ocean. However, inputs of N_2 to the major abyssal water masses from physical processes, such as injection of air bubbles, complicate the simple budget.

3B5.1 ID:4823 10:30

Schoolyard and Public Space Heat Islands: A Study in Windsor-Essex, Sarnia-Lambton and Chatham-Kent, Ontario

Carol Moogk-Soulis
Technical Aids Consulting Services
Contact: camoogk_soulis@yahoo.com

Schoolyards and public spaces are hot places. Excess heat is associated with lower physical activity and higher ultraviolet ray exposure. This study sampled 275 schoolyards and 529 public spaces in Southwestern Ontario in 2009 using Landsat 7 satellite imagery, parcel boundaries and Google Earth data. In contrast with earlier studies, the use of parcel boundaries and Google Earth data improved the ability to interpret heat conditions in and around the study sites. Average surface temperatures ranged from 9.0 to 103°C. Site rankings based on these results provide an objective basis for decision-makers to allocate heat mitigation resources. Shade from trees is found to be the best heat mitigation strategy. Policy is needed to mandate and protect trees used to shade and cool schoolyards and public spaces to enable healthy and safe outdoor activity.

2D0.5 ID:4824 17:00

Long-Term Trends in the Physical Environment along the Northwest Passage Shipping Route

Mar Martínez De Saavedra Álvarez , *David Fissel* , *Nilgun Kulan* , *Randy Kerr* , *Todd Mudge*
ASL Environmental Sciences Inc
Contact: dfissel@aslenv.com

The Arctic Ocean has experienced dramatic reductions in the areal extent of sea ice in late summer over the past decade. These changes in the Arctic Ocean ice regime, and related changes in the atmospheric and oceanic climate, have received widespread attention in terms of the implications of these changes for shipping and oil and gas exploration activities.

This paper provides an updated analysis of observed trends over the past 50 years or longer at locations along the Northwest Passage shipping route from Barrow, Alaska, in the west to Resolute Bay, Nunavut, in the east. The long-term trends in meteorological (air temperature and winds), sea ice and oceanographic (ocean waves) parameters are computed from coastal weather station data sets, published sea ice charts and other studies. The relevant sea-ice types are: old ice; thicker and heavily deformed first year ice, which can include very deep ice keels and hummocky ice; and landfast ice.

The trends towards reduced total ice concentrations in late summer in the Alaskan Beaufort and the deeper offshore waters of the Canadian Beaufort Sea, are -11.4 and -7.3% per decade, respectively, which is comparable to that of -11.1% per decade in the overall Arctic Ocean. Sub-regions in the central Canadian Arctic present smaller trends at +1 to - 6% per decade. In some sub-regions, the overall linear trends are comparable to the level of interannual variability, while in others the interannual variability is considerably larger than the decadal change. The trends computed for old ice can be quite different from that of total ice concentrations. The results of a similar analysis of trends in the meteorological and oceanographic parameters will also be presented.

2D0.1 ID:4825 16:00

The Response of Sea Ice Drift to Wind and Current Forcing in the Canadian Beaufort Sea

Keath Borg [1], *Nilgun Kulan* [1], *David Fissel* [1], *Humfrey Melling* [2]
[1] ASL Environmental Sciences Inc
[2] Institute of Ocean Sciences DFO
Contact: dfissel@aslenv.com

Ice motion is primarily driven by winds and ocean currents. The forces exerted by wind and current depend upon ice smoothness via the drag coefficient, which is in turn related to the ice concentration and ice type. Inertial oscillations of the ice cover are the result of temporal changes in the balance of forces on the ice initiated by passing weather systems, and are also affected by the forcing, and variations in the upper ocean density and velocity gradients. There are large seasonal variations in the effectiveness and impact of ice-ocean coupling mechanisms. In this study, long-term ice drift and water column velocity measurements are used to investigate these different factors influencing ice drift, using multi-year data acquired by the Institute of Ocean Sciences (DFO) at two sites on the Canadian Beaufort Sea continental shelf. To isolate the ice responses for inertial oscillations, the data were band-pass filtered to examine periods between 8 and 19 hours and again low-pass filtered to retain only synoptic (sub-inertial) time scales in excess of 22 hours. Ice response factors were classified by season, when possible. Wind forcing is usually strongest on sub-inertial time scales, but the ocean currents apply forcing in the inertial band. As ice concentration increases, the response of the ice to both wind and current forcing decreases, reflecting the increasing importance of ice-borne stress in compact pack ice. Our preliminary results suggest that, at synoptic time scales, the ice response to wind is smallest for thick first-year ice, and is similar for both thin ice and old ice. At inertial time scales, the ice response to current forcing is affected by seasonal variations in upper ocean properties. It also exhibits variations between different ice type properties. Some explanation of the differing responses among ice types will be attempted.

1B0.1 ID:4826 INVITED/INVITÉ 11:00

An Improved Approach to Air Quality Forecasting: Implications for Municipal Planning and Public Health Promotion

Xin Qiu [1], *Louise Aubin* [2], *Ron Haley* [1]
[1] Novus Environmental Inc.
[2] Region of Peel, Department of Public Health
Contact: xinq@novusenv.com

The epidemiological evidence clearly shows that existing levels of urban air pollution is adversely affecting human health. The CMA estimates that by 2013 nearly 90,000 people will die from the acute effects of air pollution and there will be more than 700,000 deaths due to long-term exposures, with the economic cost accumulating to over $250 billion . Sensitive populations including children, the elderly, people with allergies, asthma or heart and lung conditions are more vulnerable and face greater risk.

While municipalities are aware that poor air quality affects health and are exploring ways to improve local air quality, they do not have the authority to regulate air emissions. However, they can influence many local emission sources and how communities are designed. Municipalities have the opportunity to reduce air pollution related health impacts through land use planning strategies that reduce exposure such as land use compatibility guidelines and set-back’s based on air quality considerations. Improved understanding of the local factors that contribute to air quality and how future land use development and transportation strategies influence air quality is needed to help municipalities develop strategies to improve local air quality.

This presentation identifies the factors that influence air quality at a municipal level, and presents an

improved forecasting approach that can predict regional and local scale air quality impacts at high resolution. How this system can be used to predict changes in air quality resulting from new development and changing patterns of emissions is discussed. A municipal perspective on how this information can be used to guide development where there are sensitive land uses in close proximity to major sources of air pollution is presented.

4C5.5 ID:4828 14:45

The role of trophic and size structure in the stability and productivity of soft-bottom invertebrate communities

Tara Macdonald [1], *Brenda Burd* [1], *Albert Van Roodselaar* [2]
[1] Department of Fisheries and Oceans
[2] Metro Vancouver
Contact: Tara.Macdonald@dfo-mpo.gc.ca

Invertebrate communities occupying marine sediments provide a number of services to the ecosystem, including carbon transfer through food webs and the accumulation of consumer biomass (secondary production). We investigate the size and trophic structure of macrobenthic (organisms >1mm) communities across depth, percent fines, and organic flux regimes in order to understand how these functions are modified in different habitats in the Strait of Georgia. We find evidence for widespread trophic opportunism, and therefore an economy of trophic function across depths and substrate types. This function is modified by the trend for the increasing body size (and therefore overall biomass) of burrow-dwelling sub-surface deposit feeders in both deep, muddy habitats and in sediments under the influence of high organic flux of the Fraser River. In these communities, production per unit biomass is low due to the presence of large, long-lived subsurface deposit feeders, which may be resistant to both low oxygen conditions and high inorganic input. This research is part of a collaborative agreement between the Department of Fisheries and Oceans and Metro Vancouver.

1P705.2 ID:4829 16:00

A Study of the Impacts of Local Emissions on the AQHI in Pictou, Nova Scotia

Daniel Jubainville , *Doug Ee Steeves* , *David Waugh* , *Chantelle Layton*
Environment Canada
Contact: douge.steeves@ec.gc.ca

As part of a pilot project testing advisories for the Air Quality Health Index (AQHI) in Nova Scotia , Special Air Quality Statements were issued for events in the moderate risk category (AQHI 4 to 6). Of the 58 statements issued, 26 included Pictou. In a majority of these cases, PM2.5 was the principle cause of elevated AQHI values and this occurred when the meteorological conditions were such that the monitoring station was directly downwind from a strong local source, in this case a pulp and paper mill. Local sources present a challenge to forecasters when they have a significant effect on the AQHI. This study will use the relationships between meteorological variables and the AQHI to examine the impacts of local sources. Seasonal and diurnal dependencies will be studied as well. Ice cover will be considered to look for a signal of sea salt aerosols in the PM2.5 mass. This study will yield a better understanding of the relationships between meteorological factors, emission sources and the AQHI and will lead to the development of tools and/or techniques to help forecasters improve the AQHI forecasts and advisories for Pictou and other communities with similar local source issues.

4B4.3 ID:4830 11:15

Forcing mechanisms for variations of sea surface height and circulation in the North Atlantic

Zeliang Wang [1], *Youyu Lu* [1], *John Loder* [1], *Dan 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 the forcing mechanism for sea surface height (SSH) and circulation variations in the North Atlantic. At decadal time scales, the variations of SSH are mainly driven by heat forcing while the variations of barotropic circulation are wind driven except in the subpolar region where the heat forcing is important. The variations of the meridional overturning circulation (MOC) at 48oN and the strength of the subpolar gyre are correlated, and the MOC lags the winter NAO index by 3 years. The MOC at 32oN is correlated with the index of the East Atlantic pattern (EAP). At the inter-annual time scale, the variations of SSH are mainly driven by heat forcing and well represent the variations of the barotropic circulation; wind forcing is important in the subpolar and central regions of the North Atlantic

3P706.1   ID:4831   15:30

An Effective and In-Expensive Acoustic Test Tank Facility for High Frequency Active Sonar Instruments

David Lemon [1], *Martin Taillefer* [2], *Jan Buermans* [1], *Paul Johnston* [1], *Murray Clarke* [1]
[1] ASL Environmental Sciences
[2] Maritime Way Scientific Ltd.
Contact: martin.taillefer@sympatico.ca

An acoustic test tank facility has recently been designed, commissioned and is now in use for calibration and testing of high frequency active sonar instruments at ASL Environmental Sciences. The sonar instruments requiring testing and calibration use one or more narrow band acoustic transducers with frequencies ranging from 125 kHz to 775 kHz, and operate with beamwidths of 1.8 to 11 degrees. The acoustic tank can accommodate frequencies as low as 50kHz. The all steel acoustic test tank is cylindrical with a diameter of 2.43 m and total along beam length of 6.10 m having a total water volume of 28.5 m^3. Initial tests with a 420 kHz and a 125 kHz instrument showed a significantly higher level of reverberation arising from the end-wall echo (compared to a smaller tank previously used for testing these instruments). Using basic raypath modeling, the propagation showed that reducing the reflectivity of the end wall would greatly reduce the reverberation. Materials available to damp reverberations were investigated, such as linings coated with ultrasonically absorbent tiles. Anechoic tiles are very costly, ranging from $1,500.00 to $2,500.00 per square meter. Modelling results suggested that more common materials such as log-pile carpeting or artificial turf could be adequate. Doormats made of a coarse artificial turf material were found to be highly effective (and economical)) in tests with the 125 and 420 kHz instruments. Tests were used to define the effects of sidelobe patterns on the acoustic environment and to determine the optimum positions for calibration targets. Results using an acoustic propagation model of the tank to predict instrument performance will be presented.

1P602.3   ID:4832   16:00

The Canadian Precipitation Analysis (CaPA): Near real-time precipitation mapping in poorly gauged northern latitudes using optimal interpolation and considering solid precipitation measurement issues

Vincent Fortin [1], *Guy Roy* [2], *Craig Smith* [3], *Frank Lespinas* [4], *Daniel Deacu* [1]
[1] Meteorological Research Division, Environment Canada
[2] Meteorological Service of Canada, Environment Canada
[3] Climate Research Division, Environment Canada
[4] Department of Civil Engineering, University of Manitoba
Contact: guy.roy@ec.gc.ca

Mapping precipitation in near real-time is difficult even in data-rich environment, due to the high temporal and spatial variability of precipitation but also because of the challenges associated with accurate measurements of precipitation, and especially of solid precipitation. In most of Canada, precipitation monitoring stations are often few and far between and very often fully automated. Nonetheless, mapping precipitation in near real-time remains important for many purposes, including flood forecasting, forest fire prevention, and numerical weather prediction. In close collaboration with provincial partners, Environment Canada is developing a Canadian precipitation analysis to address these needs by (1) gathering information on precipitation from different sources, (2) integrating networks of ground stations from different partners into a network of networks, (3) performing a strict quality control analysis, and (4) using optimal interpolation to combine these observations with a short-term precipitation forecast. In this poster we present the Canadian Precipitation Analysis produced in operational mode at CMC and then focus on the quality control of solid precipitation measurements from both manned and automated precipitation gauges and its impact on the bias and skill of the precipitation analysis.

2D6.2 ID:4833 16:30

Turbulent Collapse in Stratified Free Shear Layers: The Role of Secondary Instability

Ali Mashayek , *W. R. Peltier*
University of Toronto
Contact: amashaye@atmosp.physics.utoronto.ca

We study the processes through which three dimensional turbulence develops in stratified free shear layers. In particular, we investigate the impact of various secondary instabilities on the mechanism of transition. Upon saturation of the primary two dimensional KH billow, a family of secondary instabilities inevitably develops. In a density stratified fluid, the vortex streaks that are precursory to turbulent collapse in relatively low Reynolds number laboratory flows arise as a consequence of a convective instability that is focused in the “eyelids” of the billows where the originally stable density gradient is inverted. However, recent observations and two-dimensional numerical simulations have demonstrated the possibility of a secondary shear instability developing on the braids connecting the cores of individual KH billows. The pairing instability in which adjacent vortex cores merge is a further mode of secondary instability which has been observed in both laboratory experiments and numerical simulations. In this study, we investigate the competition between these three secondary instabilities for control of the transition process and provide probability maps for their regions of dominance in parameter space. We address two primary questions. First, we assess whether there may exist regions of parameter space in which the secondary braid instability observed in two-dimensional numerical simulations may precede the development of the secondary shear aligned convective instability and therefore inhibit its occurrence. Second, we investigate issue as to why the pairing instability, which has been well documented in low resolution laboratory experiments, is rarely (if ever) observed in the train of KH waves formed in oceanic and atmospheric shear layers.

4B2.4 ID:4835 11:15

Objective climate scenario selection for impacts analysis and adaptation to climate change.

Travis Logan [1], *Nicolas Casajus* [2], *Catherine Périé* [3]
[1] Ouranos
[2] Université du Québec à Rimouski
[3] Direction de la recherche forestière, Ministère des Ressources Naturelles et de la Faune Québec
Contact: logan.travis@ouranos.ca

A large ensemble of climate simulations is currently the best estimator of future climate conditions as it incorporates the principle sources of known uncertainties. At present there exists no method that enables a reduction of ensemble uncertainty and as such adequate coverage of possible future conditions is a priority when selecting climate scenarios for use in climate change impacts and adaption (I&A) research projects. Ideally, in order to well define projected future climate uncertainty, I&A projects requiring climate scenario information would incorporate a wide variety of future scenarios produced from a large ensemble of climatic simulations. In reality, there are often constraints on the number of scenarios I&A researchers can reasonably incorporate in their analyses and a selection of a reduced number or sub-set of scenarios is required. Cluster analysis, a statistical technique for unsupervised data classification, is presented as a flexible and objective method for climate scenario selection. Using a non hierarchical clustering approach (k-means clustering), climate scenarios for a given I&A project and region produced from a large ensemble of simulations are classified into a number of sub-groups according to projected changes in multiple climatic variables of interest. A single representative climate simulation per sub-group is then retained for subsequent analyses. This technique has the advantages of allowing an objective and substantial reduction in the number of climate scenarios used in I&A analyses while still providing coverage of a large proportion of the climatic ensemble's total variance of projected changes for the variables of interest. Example applications where the selection technique has successfully been used will be given from research projects investigating climate change impacts on biodiversity and forest productivity.

1C0.1 ID:4836 INVITED/INVITÉ 14:00

Investigation of size-resolved parameterizations for below-cloud particle scavenging

Leiming Zhang [1], *Xihong Wang* [2], *Michael Moran* [1]
[1] Air Quality Research Division, Science and Technology Branch, Environment Canada
[2] Kellys Environmental Services, Toronto, Canada
Contact: leiming.zhang@ec.gc.ca

A parameter known as scavenging coefficient (Gama) has been used in mass continuity equations in chemical transport models to represent below-cloud scavenging processes. A detailed review has been conducted of current size-resolved parameterizations of below-cloud particle scavenging by rain, including the theoretical formulations of Gama, the associated input parameters, and comparisons with size-resolved Gama values obtained from field measurements. The three dominant factors in the theoretical formulations of Gama – raindrop-particle collection efficiency, raindrop number size distribution, and raindrop terminal fall velocity – are investigated though numerical sensitivity tests. The differences in the predicted particle concentrations due to the use of different Gama parameterizations can be larger than a factor of 10 for ultrafine and coarse particles even after a small amount of rain (e.g., 2-5 mm). Predicted bulk concentrations (integrated over the particle size distribution) from using different theoretical and empirical Gama parameterizations can differ by up to 50% for particle number and by up to 25% for particle mass after just 2-5 mm of rain. The large differences between theoretically calculated and field observed Gama, that is larger than the

uncertainties that can be explained by various input parameters in theoretical Gama, were identified to be caused by the contributions of turbulence and vertical diffusion to the field measurements of Gama. The impact of using different theoretical Gama at regional scales is under investigation using a Canadian air-quality model; and parameterization of theoretical Gama by snow-scavenging is also under investigation.

2C6.4 ID:4837 14:45

Analysis of Precipitation and 2m Temperature from the NARCCAP regional Climate Projection Ensemble.

Sébastien Biner
Ouranos
Contact: biner.sebastien@ouranos.ca

The North American Regional Climate Change Assessment Program (NARCCAP) is a project that aims at studying the uncertainty related to regional climate projections run at a nominal resolution of 50 km. It also supplies the scientific community with a considerable ensemble of climate simulations over a region covering most of North America at the regional scale. These simulations are produced from six Regional Climate Models (RCMs) using different sources of large-scale information in recent and future climate.

Results of an analysis of the Precipitation and 2m Temperature fields from the NARCCAP ensemble are presented. The analysis covers RCM simulations using reanalysis and recent climate simulations produced by General Circulation Models (GCMs). We also present results from each of the climate change projections, focusing on the similarity and differences between the projections of the different RCMs

3C2.1 ID:4838 INVITED/INVITÉ 13:30

Informing Adaptive Responses to Climate Change in the Prairie Provinces

Dave Sauchyn , *Elaine Barrow* , *Suzan Lapp* , *Jeannine St. Jacques*
PARC, University of Regina
Contact: sauchyn@uregina.ca

Recently the Prairie Adaptation Research Collaborative (PARC) has been advancing regional adaptation planning by managing the Prairies Regional Adaptation Collaborative (RAC) on behalf of the Prairie Provinces. The Prairies RAC has four main themes: Water, Terrestrial Ecosystems, Drought and Excessive Moisture, and Adaptation and Resilience Forums. Our approach to developing climate and water scenarios is strongly influenced by the nature of the climate of Canada’s western interior and the vulnerabilities of the communities and economies to fluctuations in climate and water supplies. The western interior has Canada’s most variable hydroclimate; drought in this region is the country’s most costly natural disaster. GCM projections of increased annual temperature and precipitation are the least challenging scenarios; in fact, they are generally favourable. The most challenging consequences of regional climate change are shifts in precipitation and surface water supplies between seasons, years and decades. Hydrological models driven with climate change data consistently project less water in summer and more in winter. The corresponding adaptive strategies are relatively familiar and feasible compared to the adaptive responses to an increase in the magnitude of interannual to interdecadal variability and the frequency and severity of extreme events. Because regional climate extremes and variability are closely linked to drivers of the internal variability of the

climate system, our approach to informing adaptation is to 1) identify GCM and RCM experiments that reasonably simulate the SST and SLP patterns (ENSO, PDO, NAO) that correlate with regional hydroclimate variability, 2) for these climate models, examine trends in the time series of teleconnection indices, 3) generate probability plots for hydroclimate indices using output from multiple and re-sampled GCM and RCM experiments, 4) explore the underlying interannual to interdecadal variability of the regional hydroclimate using high-resolution paleoclimate records, and 5) communicate to stakeholders the uncertainty in the climate and impacts scenarios.

2B6.5 ID:4839 11:45

Impact of the Madden-Julian Oscillation on the intraseasonal forecast skill of the North Atlantic Oscillation

Hai Lin [1], *Gilbert Brunet* [1], *Juan Sebastian Fontecilla* [2]
[1] Meteorological Research Division, Environment Canada
[2] Canadian Meteorological Centre, Environment Canada
Contact: hai.lin@ec.gc.ca

Using the output of the intraseasonal hindcast experiment conducted with the GEM global atmospheric model during 24 extended winters, the association between the forecast skill of the NAO and the amplitude and phase of the MJO in the initial condition is investigated. It is found that with a lead time up to about one month the NAO forecast skill is significantly influenced by the existence of the MJO signal in the initial condition. A strong MJO leads to a better NAO forecast skill than a weak MJO. An initial state with an MJO phase corresponding to a dipole tropical convection anomaly in the eastern Indian Ocean and western Pacific favors a more skillful NAO forecast than an MJO phase with a single tropical convection anomaly near 120E. These results indicate that it is possible to increase the skill of the NAO and the extratropical surface air temperature intraseasonal forecast with an improved tropical initialization, a better prediction of the tropical MJO and a better representation of the tropical-extratropical interaction in dynamical models.

1P306.5 ID:4840 16:00

Testing the Performance of Coastal Ocean Observational Systems with Ensemble Methods

Pierre De Mey [1], *Nadia Ayoub* [1], *Julien Lamouroux* [2], *Matthieu Le Hénaff* [3]
[1] LEGOS
[2] NOVELTIS
[3] U. Miami
Contact: pdm789@gmail.com

We address the question of how the performance of multisensor, space- and marine-based observational systems of the coastal ocean can be characterized, on the basis of how they add value on top of pre-existing knowledge and of prior state estimates. This is explored both on a theoretical and practical point of view, with the objective of helping the design of coastal observational systems, and helping sponsors make decisions about them. The development of coastal ocean modeling in the recent years has allowed an improved representation of the associated complex physics: coastal current systems, tides, internal wave generation, ocean/atmosphere interactions. Validated realistic models can now be used to design observational systems in coastal areas, with the idea that a “good” array is an array that can detect (and hence help control) prior state error. Estimates of prior state errors are obtained through stochastic methods, such as stochastic modeling or Ensemble Kalman filters. An integrated approach because it looks at whole arrays at a time is the ARM (Analysis of the Representer Matrix) method (Le Hénaff et al., 2009; De Mey, 2010). Although ARM is easily set up

as a “black box,” the utility of its results is maximized by previous knowledge of state error physics. The technique provides both quantitative (singular value spectrum) and qualitative (singular vector) tools to study and compare various array options. Examples of ARM analysis of various types of measurements are given in the coastal ocean – namely the Bay of Biscay, with priors generated by a 3D, free surface model including tides. A discussion on the impact of those various types of observations in the framework of cross-slope exchanges, coastal mesoscale events and shelf processes is also given.

4B6.3 ID:4841 11:15

Do decadal hindcasts capture the recent pause in global warming?

John Fyfe , *Bill Merryfield*
Canadian Centre for Climate Modelling and Analysis
Contact: john.fyfe@ec.gc.ca

Over the past fifty-years global average surface temperature has warmed by about 0.6 C due to anthropogenic increases in well-mixed greenhouse gases. However, the trend in global surface temperature has leveled off over the last decade despite continuing increases in well-mixed greenhouse gases. Combining a modelling system that predicts internal natural variability and externally forced change with a new diagnostic technique that separates the two we explore possible reasons for the recent pause in global warming.

3B5.3 ID:4842 11:00

Climate Connections to Insects and Diseases in the Canadian Prairies

Virginia Wittrock [1], *Elaine Wheaton* [1], *Grace Koshida* [2]
[1] Saskatchewan Research Council
[2] Environment Canada
Contact: wittrock@src.sk.ca

Human health is linked with climate and weather patterns and the Canadian Prairies may experience more negative health burdens due to vector-borne diseases as the climate warms. In recent years, new diseases such as West Nile Virus have occurred in the Prairies. Other diseases such as Lyme Disease are also emerging with the changing climatic and ecosystem conditions. This presentation covers two key areas. First an examination of the climatic conditions associated with two extreme West Nile virus years and one very low year in two Saskatchewan communities will be given. This shows that antecedent weather conditions do influence mosquito numbers as does warm summer weather, especially the daily low temperatures. Second, a preliminary examination of the relationship of climate, ticks (I. scapularis), and Lyme disease is presented as well as assessing the potential future activity in the Canadian prairies. As the climate changes, the expansion of endemic I. scapularis tick populations is almost a certainty. Birds will be able to re-locate ticks and the associated B. burgdorferi into more regions as the endemic regions expand farther northward. The effect of humans ranges from mild illness to death. Therefore, the more we know about how these diseases spread, what their vectors are and what climatic and ecosystem conditions are required for their survival, spread and advancement, the more proactive Canadians can be to decrease future outbreaks and their resulting negative impacts.

1P403.1 ID:4846 16:00

Projected changes to multi-day precipitation extremes over Quebec watersheds using a multi-RCM ensemble

André Monette [1], *Laxmi Sushama* [1], *Naveed Khaliq* [2], *René Roy* [3]
[1] UQAM département des sciences de la Terre et de l'atmosphère, réseau MDCR
[2] Environment Canada, Adaptation and Impacts Research Division (EC-AIRD)
[3] Hydro-Québec
Contact: dd.031986@gmail.com

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 May to October multi- day precipitation extremes, i.e. 1-, 2-, 3-, 5-, 7- and 10 day, for the 2041– 2070 future period with respect to the 1971–2000 current period, using a multi- RCM ensemble available through NARCCAP project, at watershed scale. Regional frequency analysis based on L-moments is used in this study. Preliminary results suggest an increase in studied precipitation extremes for all 21 watersheds considered in this study in the 10 to 15% range for southern and central Quebec watersheds, while higher increases of the order of 30% is projected for northern Quebec.

1B4.3 ID:4848 11:30

Application of a Multi-Nested Ocean Circulation Model for Investigating Circulation, Flushing Time and Dispersion in Halifax Harbour and Adjacent Waters

Shiliang Shan , *Jinyu Sheng*
Dalhousie University
Contact: sshan@phys.ocean.dal.ca

A multi-nested coastal ocean circulation modelling system is used to simulate the three-dimensional circulation and hydrography of Halifax Harbour forced by tides, wind and sea level pressure, surface heat fluxes and terrestrial buoyancy fluxes associated with river and sewage discharge. The multi-nested modelling system has a five-level downscaling with a coarse-resolution (1/12°) outer-most model for the eastern Canadian shelf and a fine-resolution (~200 m) inner-most model for Halifax Harbour, Bedford Basin and adjacent waters. The results produced by the inner-most model are used to examine the role of tides, wind forcing and freshwater discharge in driving circulation and dispersion in the study region. The dispersion and retention in the Harbour are studied based on numerical passive tracer and particle tracking experiments. The e-folding flushing time is estimated to be about 40 and 90 days in the upper and entire Bedford Basin, 2-5 days over the Inner and Outer Harbour, and about 1 day in the Narrows. Hydrodynamic connectivity in the Harbour is also examined using a transition matrix calculated from particle trajectories. Within five days under calm conditions, about 75% and 85% of particles remain in Bedford Basin and the Northwest Arm, respectively; and nearly 90% of particles are flushed to the open sea in the Outer Harbour. Our results also demonstrate that particle movements and hydrodynamic connectivity in the Harbour vary significantly during different storm events.

3B3.3 ID:4849 11:00

Determination of acidification state of the Canadian Pacific coastal waters using empirical relationships with hydrographic data

Alejandra Lara-Espinosa [1], *Debby Ianson* [2], *Adam Monahan* [1]

[1] University of Victoria
[2] Fisheries and Oceans Canada
Contact: chuntariux@gmail.com

In many regions of the ocean, the aragonite saturation horizon has shoaled as a result of the uptake of anthropogenic carbon dioxide (CO2). It is particularly shallow in the Northeastern Pacific ocean and it has been suggested that undersaturated waters with respect to aragonite can be transported onto the continental shelf and into the surface during periods of upwelling. This study aims to develop a multiple linear regression (MLR) model to robustly determine aragonite saturation state (Omega-arag) and carbonate ion concentration [CO32-] from observations of different hydrographic parameters using data collected along the Pacific coast of Canada primarily in late May 2007 and early August 2010. The ability of the algorithm to compute realistic estimates of Omega-arag and [CO32-] has been assessed by exploring the strong correlations between potential predictors and their effect on the MLR. Application of the MLR approach to data from different depth ranges has also been explored as has the mechanistic relationship between predictors and both Omega-arag and [CO32-]. A first regression model that captures the most relevant factors that influence the region will be presented and the choice of predictors discussed. It is the goal of this research to use this MLR to reconstruct annual Omega- arag and [CO32-] cycles using the historical data available.

1P403.2 ID:4850 16:00

Canadian RCM projected changes to extreme flows in Quebec watersheds

Jacinthe Clavet-Gaumont [1], *Laxmi Sushama* [2], *Naveed Khaliq* [3], *René Roy* [4]
[1] UQAM département des sciences de la Terre et de l'atmosphère, réseau MDCR
[2] Centre ESCER (Étude et Simulation du Climat à l'Échelle Régionale), Université du Québec à Montréal,
[3] Adaptation and Impacts Research Section, Atmospheric Science and Technology Directorate, Environment
[4] Hydro-Québec, Ouranos
Contact: clavet@sca.uqam.ca

Intensification of the global hydrologic cycle is expected in future climate and the associated changes in the intensity and frequency of hydro-climatic extremes can have significant impacts on various sectors including the energy sector. The energy sector holds a predominant place in Quebec economy, with 96% of consumed electricity coming from hydroelectric generating stations of Hydro-Quebec. In the northern parts of Quebec, storage power stations represent 95% of installed capacity, due to the great seasonal fluctuations in streamflows, while run-of-river power stations, highly dependent on natural run-off, accounts for 95% of installed capacity in the south. Information related to changes in streamflow characteristics are important in the management and future planning/adaptation of these hydroelectric reservoirs and power stations in the context of a changing climate. In this study, projected changes to selected return levels of Canadian RCM simulated extreme flows for 21 Quebec watersheds is assessed following the Regional Frequency Analysis (RFA) approach. The RFA is based on homogeneous regions and substitutes space for time by pooling data over identified homogeneous regions. Results related to the identification of homogeneous regions, and projected changes to 10- and 30-year return levels of 1-day high flows and 7-day low flows for the studied basins will be presented in this paper.

4D5.3 ID:4851 16:15

Co-incident in-situ observations of turbulence and zooplankton with a new biophysical profiler

Tetjana Ross , *Candace Smith*

Department of Oceanography, Dalhousie University
Contact: tetjana@dal.ca

Turbulence is ubiquitous in the oceanic environment and it has been theorized that, depending on its intensity, turbulence can either enhance or inhibit feeding by zooplankton. This has been supported by laboratory experiments, but whether turbulence is an important factor in the ocean is poorly known because of the difficulty of making simultaneous measurements of zooplankton and turbulence in-situ. We present data from a newly constructed vertical profiler that combines video plankton and microstructure measurements. Examining data from three distinct deployments, a relatively stable fjord setting (Saanich Inlet), a tidally-driven estuarine system (Bedford Basin) and a dynamic continental shelf setting (Roseway Basin), we relate the small-scale physical complexity of the water column (represented by turbulence dissipation rates and temperature variance) to distributions and size-spectra of zooplankton. We also critically explore putative evidence of biologically generated turbulence in the fjord.

2B6.2 ID:4852 11:00

Forecast skill of Madden-Julian oscillation in CCCma coupled ocean-atmospheric models

Ajayamohan Ravindran , *Bill Merryfield*
Center for Climate Modelling and Analysis
Contact: Ajaya.Mohan@ec.gc.ca

The daily outputs of two CCCma coupled ocean-atmospheric models participating in the World Climate Research Program’s Climate-system Historical Forecast Project (CHFP) are utilized to assess skill in predicting the Madden-Julian Oscillation (MJO). The models are the CanCM3 and CanCM4 coupled model versions, based respectively on CCCma’s third and fourth generation general circulation models. The study uses a large data set comprised of ten-member ensembles of three variables (OLR and lower and upper-level zonal winds) for the period 1979-2008 for each model. These variables are used to construct a bivariate index representing the amplitude and phase of the MJO. The ability of forecasts from the two models to predict this index will be described and related to the nature of MJO-like variability in corresponding freely-running simulations.

2D0.6 ID:4853 17:15

A SAR Feature Database for Sea Ice Data Assimilation

Lynn Pogson , *Tom Carrieres* , *Mark Buehner*
Environment Canada
Contact: lynn.pogson@mail.mcgill.ca

Version one of an operational sea ice analysis for North America was recently implemented at the Canadian Meteorological Center (CMC). This system uses a 3D-Var method to assimilate ice concentrations retrieved from passive microwave (AMSR-E and SSM/I) and from the Canadian Ice Service (CIS) charts. In future versions of this system, observations from additional sensors will be assimilated, including synthetic-aperture radar (SAR). It is expected that SAR observations can be used to distinguish ice and water at high resolution and to possibly infer ice thickness. As the first step in this process, we are building an extensive SAR and environmental database containing information required to develop optimal SAR features and ultimately to build forward models. The database will include data from thousands of SAR images and corresponding background ice concentration from the

sea ice analysis system, as well as environmental fields such as wind speed and direction, air temperature, etc. This presentation will provide a status report on the project and some early results.

1P205.4 ID:4854 16:00

A cluster analysis of back trajectories to evaluate transport of PM2.5 in southern Quebec

Pamela Lehr
Environment Canada
Contact: pamela.lehr@ec.gc.ca

PM2.5 (particulate matter, diameter < 2.5 µm) poses a serious health concern, making it necessary to continually improve our understanding of sources and conditions that lead to high PM episodes. Cluster analysis of back trajectories has regularly been used to better understand source-receptor relationships. The resultant clusters of similar trajectories are assigned to a respective site's PM2.5 data to provide insight into links between transport patterns and PM2.5 concentrations. As back trajectories do not provide information regarding meteorological conditions that may limit PM2.5 concentrations, a publicly available database of daily weather classification, SSC (Spatial Synoptic Classification) scheme, can be used to provide some detail as to the likely meteorological conditions at the receptor site.

In this study we use cluster analysis of CMC (Canadian Meteorological Centre) back trajectories, PM2.5 concentrations, and the SSC scheme to improve our understanding of PM2.5 source-receptor relationships in southern Quebec. As well, our results are used to evaluate a previously built source-receptor tool, START (Suivi du Transport Atmosphérique Régional et Transfrontalier), which estimates pollutant loading by summing a specificied pollutant along a back trajectory based on an underlying emissions field.

1P308.3 ID:4855 16:00

Hydrographic and Circulation Variability in the Orphan Basin Region during the Past Decade

John Loder , *Igor Yashayaev* , *Yuri Geshelin* , *Blair Greenan*
Fisheries and Oceans Canada, Bedford Institute of Oceanography
Contact: John.Loder@dfo-mpo.gc.ca

The evolution of the western boundary flows exiting southward from the Labrador Sea along the Northwest Atlantic's complex continental margin is an important issue to the downstream influences of the subpolar gyre, as well as to the Atlantic Meridional Overturning Circulation. Using the Labrador Sea's AR7W line as an upstream reference, variability in the boundary flows and water mass properties in the Orphan Basin region north of the Flemish Cap complex will be described. The analysis will draw on moored measurement and survey programs in Flemish Pass during 2002-2005, Orphan Basin (OB) during 2004-2010 and Orphan Knoll during 2008-2010. The observations indicate that there is slow (0.05-0.10 m/s) flow through OB (in an equatorward sense) with near-bottom intensification of the flow between the 2200 and 2800m isobaths, and a more barotropic intensification inside the 2000m isobath. Isolated tall narrow eddies and episodic upper-ocean inertial oscillations are notable energetic features at smaller scales in OB. The near-bottom mean flow on the western flank (2200m) of Orphan Knoll (at the offshore edge of OB) is northward, pointing to potential recirculation around the Knoll. Seasonal-mean transports in Flemish Pass (depth of 1100m) range from 6 Sv in summer to 9 Sv in winter. Seasonal and interannual variability of the mid-depth and deep hydrographic properties in these areas can be linked to those on the AR7W line, allowing identification of flow pathways and estimation of transit times.

2B5.3 ID:4856 11:15

A year of benthic community responses to fluctuating oxygen levels assessed through online observations

Marjolaine Matabos [1], *Courtney Dean* [1], *Kim Juniper* [2], *Verena Tunnicliffe* [3]
[1] SEOS, University of Victoria
[2] SEOS/Biology, University of Victoria
[3] Biology/SEOS, University of Victoria,
Contact: verenat@uvic.ca

Seafloor communities can respond rapidly as oxygen levels change in response to chemical and physical factors in the ocean. This study examines the rate and character of macrofaunal responses to oxygen levels over the course of a year. Saanich Inlet, BC, is a highly productive fjord where extreme hypoxia has a seasonal signal. The study site, at 104 m depth, is part of the VENUS subsea observatory that delivers data via cable and allows interactive access to instruments, including cameras. We conducted a high-resolution time-series photographic survey to determine animal abundances in relation to changes in environmental variables. Photos of the seafloor were taken with a remotely-controlled digital still camera every 2/3 days over 13 months, and analyzed manually for community composition, species behaviour and sediment characteristics. Dissolved oxygen concentrations varied between 0.02 and 2.5 ml.l-1 showing a seasonal change. However, variability on short time-scales (hours) was very high especially as levels increased. With higher oxygen, more species migrated into the area while other left, modifying interactions within and among species. Animal densities were high indicating that the risk from hypoxia is balanced by factors such as food availability and escape from less tolerant predators. It is evident that a highly specialized community can develop dominated by fish and crustaceans in near anoxic conditions. Our results reveal some of the mechanisms by which hypoxia influences benthic community dynamics.

3B6.2 ID:4857 10:45

Ejection mechanism in Holmboe waves

Anirban Guha [1], *Jeffrey Carpenter* [2], *Gregory Lawrence* [1]
[1] University of British Columbia
[2] Swiss Federal Institute of Aquatic Science and Technology
Contact: aguha@interchange.ubc.ca

In a stratified shear layer, the interaction between a gravity wave and a vorticity wave results in Holmboe instability. This instability requires a relatively thin density interface in comparison to the shear layer thickness. It's ability of growing under conditions of strong stratification makes it a potentially important process for geophysical flows. At finite amplitude, Holmboe instability develops into a series of propagating internal waves that often appear cusp-like in form. These cusps are known to produce vertical ejections of the interfacial fluids from the wave crests. Although this ejection process is generally considered to be important for the generation of three dimensional motions, mixing of the density field and the basic evolution of the Holmboe wave field, little is known of the mechanism by which it occurs. We have conduced Direct Numerical Simulations (DNS) to study this problem. We have found that the ejected fluid is transported against buoyancy forces due to the formation of a vortex couple comprising of positive shear layer vortcity and negative baroclinic vorticity generated at the wave crests. Ejections have been found to occur only in the largest amplitude

waves, since such waves generate higher baroclinic vorticity and therefore leads to a stronger vortex couple, thereby favoring ejections. To understand whether ejections depend on three dimensional effects, and thereby to answer the question whether ejections occur erratically, we have also conducted strictly two dimensional simulations and have observed ejections taking place. However three dimensional motions have been observed to form on the ejected fluid even when the wave crests are highly two dimensional, suggesting that ejections could be a source of three-dimensionality. Earlier studies proposed that ejections are triggered by the interaction of upper and lower Holmboe waves. To verfiy this claim, we have conducted simulations with asymmetric shear layers (i.e. when the shear layer centre is at an offset with that of density). Under such conditions, Holmboe waves appeared only in one layer. We have observed ejections under this condition which implies that interaction between upper and lower Holmboe waves is not a necessary condition for ejections. However, our simulations suggest that wave interactions favor ejections. A simplified theoretical model has also been proposed in which the vortices are considered as point vortices and thereby the trajectory of the ejected fluid is estimated.

2D3.5 ID:4858 17:00

Climate Change, Anthropogenic Aerosols, and Impacts on Human Health.

Janya Kelly [1], *David A. Plummer David.plummer@ec.gc.ca* [2], *Paul A. Makar Paul.makar@ec.gc.ca* [3], *J. Zhang Junhua.zhang@ec.gc.ca* [3]
[1] Golder Associates Ltd, 2390 Argentia Road, Mississauga, ON, Canada
[2] Climate Research Division, Environment Canada, Montreal PQ, Canada
[3] Air Quality Research Division, Environment Canada
Contact: paul.makar@ec.gc.ca

Output from the Canadian Regional Climate Model (CRCM, v4.2.3) was used as the driving meteorology for three separate simulations of A Unified Regional Air-quality Modelling System (AURAMS, v1.3.2, bet rev 463), to study the effects of climate change on air pollution over a North American domain, at 45km resolution. The CRCM was driven using the Canadian Coupled General Circulation Model (CGCM v3.1) with SRES A2 meteorology, for the periods 1997 to 2006 and 2041 to 2050, for the months of June, July and August. In addition to a current climate scenario making use of 2002 anthropogenic pollutant emissions, the future climate scenarios were carried out using either the 2002 emissions (to study the effect of climate change on anthropogenic air-quality), and using 2020 projections of current legislated emissions levels further projected to 2050 using the IPCC Representative Concentration Pathway v6.0 database.

The current climate, current emissions scenarios were evaluated against observational data from North American monitoring networks for ozone and PM2.5 (1023 ozone stations, 278 PM2.5 stations). Standard statistical measures of model performance were used to describe the coupled modelling system's performance for these pollutants.

The model results indicate that in the presence of SRES A2 climate change and in the absence of increases in anthropogenic smog precursor emissions beyond those taking place in 2002, both tropospheric ozone and particulate matter would increase above the 1997 to 2006 levels, throughout most of North America. In contrast, when the same 2041 to 2050 SRES A2 meteorology is used in conjunction with the RCP 6.0 precursor emissions, tropospheric ozone and particulate matter would decrease relative to 1997 to 2006 levels.

The human-health related impacts of climate change and the emissions scenarios were examined using Air-Quality Health Index (AQHI) values, and will be discussed in the presentation.

4C2.3 ID:4859 14:15

Validating the downscaling of Climdex extremes for multiple methods

Gerd Buerger , *Trevor Murdock* , *Arelia Werner* , *Stephen Sobie*
PCIC
Contact: gbuerger@uvic.ca

Multiple downscaling methods including TreeGen, BCSD, EDS, Biosim, Lars-WG and ASD are evaluated in several regions of BC for their ability to replicate the statistics of extremes, as represented by the Climdex set.

To structure the evaluation we employ three consecutive tests, for each method and index:

1) Test if the observed distribution of an index is reproduced from downscaling reanalyses (NCEP).

2) As test 1, but from downscaling simulated historical climate (20C3M).

3) Test how accurately individual years are reproduced from reanalyses.

As the test data have not been used for calibration, one may "formally" conclude that method-index pairs that pass test 1 to 3 are actually validated. And this holds, in fact, for the Climdex set whose individual indices have not been used for the calibration of any of the methods.

For other climate statistics, such as mean and variability of the original variables (T and P), the situation is more complicated. The reason is that many downscaling methods are supplemented, apart from a "normal" calibration, with bias correction techniques, such as variance adjustments or trend corrections. Tests 1 and 2, by testing entire distributions, are inappropriate in such cases, due to the lack of fully independent climate data that may provide enough degrees of freedom for the test.

If time permits we will address this problem, and outline a more rigorous validation procedure that makes use of surrogate, high-resolution climates simulated by RCMs.

4B5.3 ID:4860 11:00

Acoustic Doppler Velocimetry from the VENUS Coastal Network

Richard Dewey , *Paul Macoun* , *Jeannette Bedard*
University of Victoria
Contact: rdewey@uvic.ca

Acoustic Doppler Velocimeters (ADVs) are bi-static devices for measuring the fluid velocity within a small volume, effectively providing a point measurement. When set to sample rapidly, the resulting velocity time series can be used to resolve flow characteristics covering a wide range of scales from tides to turbulence. A near-bottom Nortek Vector ADV has been deployed both autonomously and on the VENUS coastal network at several sites in the Strait of Georgia, where the tidal currents are strong. An advantage of cabled network deployments is that there are no battery or memory limitations. Data and analysis from these varied bottom boundary layer deployments will be discussed. A technique for estimating the turbulent dissipation rate using a fit to Nasmyth’s Universal spectra will also be presented.

3P407.4 ID:4861 15:30

Preliminary Results in Modeling Climate Change Along the British Columbia Coast

Wendy Callendar , *Michael Foreman* , *Diane Masson* , *John Morrison*
Institute of Ocean Sciences
Contact: wendy.callendar@dfo-mpo.gc.ca

Global climate models explore large-scale climate change, but lack the resolution to see changes on a regional level. To view these meso-scale changes along the British Columbia coast, an oceanic model has been developed. Atmospheric forcing for this model was obtained through downscaling via EOF analysis of Canadian Regional Climate Model (CRCM) data, where the anomaly was found between the current and future scenarios and added to a current, high resolution, climatology. A similar anomaly was found for the oceanic initial conditions by interpolation from output of the Canadian Global Climate Model (CGCM3). This presentation will discuss the downscaling procedure for generation of the forcing and initial fields and present preliminary results comparing model output from a current scenario run and a future scenario run.

1C4.5 ID:4862 15:00

Euphotic zone nitrate regeneration in a highly productive NE Pacific fjord: Implications for measurements of coastal new production

Damian Grundle , *Kim Juniper*
University of Victoria
Contact: dgrundle@uvic.ca

The failure to consider euphotic zone nitrification may have lead to substantial overestimates of new and export production in NE Pacific coastal waters. The new production paradigm, which for several decades now has been used as a proxy for estimating carbon export via the biological pump, relies upon the fundamental assumption that nitrification is photoinhibited and as such is restricted to the aphotic region of the water column. However, more recent evidence indicates that nitrification can occur throughout the euphotic zone, thus implying that new production, and marine biological carbon export, may have been overestimated. During the phytoplankton growing season of 2008 we conducted a comprehensive study of nitrification throughout the oxic and sub-oxic regions of Saanich Inlet, a highly productive British Columbia fjord. This presentation will draw on the euphotic zone nitrification rate measurements from our 2008 study. Results will be discussed in the context of phytoplankton nitrate uptake rates, and we will highlight the degree to which new production may be overestimated when euphotic zone nitrate regeneration is not considered.

4B3.3 ID:4863 11:00

The Probability Distribution of Land Surface Wind Speeds

Adam Monahan [1], *Yanping He* [1], *Norman Mcfarlane* [2], *Aiguo Dai* [3]
[1] School of Earth and Ocean Sciences, University of Victoria
[2] Canadian Centre for Climate Modelling and Analysis
[3] National Center for Atmospheric Research
Contact: monahana@uvic.ca

The probability density function (pdf) of land-surface wind speeds is characterised using a global network of observations. Daytime surface wind speeds are shown to be broadly consistent with the Weibull distribution, while those at night are generally more positively skewed than the corresponding Weibull distribution (particularly in summer). In the middle latitudes, these strongly positive skewnesses are shown to be generally associated with conditions of strong surface stability and weak lower-tropospheric wind shear. Long-term tower observations from Cabauw, Netherlands demonstrate that lower-tropospheric wind speeds become more positively skewed than the corresponding Weibull distribution only in the shallow (~50 m) nocturnal boundary layer. This skewness is associated with two populations of night-time winds: one strongly stably stratified with strong wind shear, and the other weakly stably or unstably stratified with weak wind shear. Using an idealised two-layer model of the boundary layer momentum budget, it is shown that the observed variability of the daytime and nighttime surface wind speeds can be accounted for through a stochastic representation of intermittent turbulent mixing at the nocturnal boundary layer inversion.

4D2.3 ID:4864 16:00

Statistical Downscaling of Sea Surface Winds in the Subarctic Northeast Pacific

Adam Monahan
School of Earth and Ocean Sciences, University of Victoria
Contact: monahana@uvic.ca

The statistical predictability of wintertime (December through February) monthly-mean sea surface winds (both vector wind components and wind speed) in the subarctic Northeast Pacific off of the West Coast of Canada is considered, in the context of surface wind downscaling. Predictor fields (zonal wind, meridional wind, wind speed, and temperature) are shown to carry predictive information on large scales (both vertical and horizontal) that are well simulated by Numerical Weather Prediction and Global Climate Models. It is found that in general the monthly-mean vector wind components are more predictable by indices of the large-scale flow than is the monthly-mean wind speed, with no systematic vertical variation in predictive skill for either across the depth of the troposphere. The difference in predictive skill between monthly-mean vector wind components and wind speed is interpreted in terms of an idealised model of the vector wind speed probability distribution, which demonstrates that for the conditions in the subarctic Northeast Pacific the sensitivity of mean wind speed to the standard deviations of vector wind component fluctuations (which are not well predicted) is greater than that to the mean vector wind components. It is demonstrated that this sensitivity is state-dependent, and it is suggested that monthly mean wind speeds may be inherently more predictable in regions where the sensitivity to the vector wind component means is greater than that to the standard deviations. It is also demonstrated that daily wind fluctuations (both vector wind and wind speed) are generally more predictable than monthly-mean variability, and that monthly-averages of the predicted daily winds generally represent the monthly-mean surface winds better than do the predictions directly from monthly-mean predictors.

2B6.3 ID:4865 11:15

Modification of an MJO Index and its Applications

Thomas Anderson [1], *Hai Lin* [2], *Jacques Derome* [1]
[1] McGill University
[2] Environment Canada
Contact: thomas.anderson@mail.mcgill.ca

The Madden-Julian Oscillation (MJO) has been shown to be the dominant component of the intraseasonal variability (30-90 days) in the tropical atmosphere. The MJO signal, convection and overturning zonal atmospheric circulations propagating slowly eastward along the equator, has been firmly established within the scientific community. However, questions remain, most notably the MJO and ENSO interaction and the behavior of the MJO on time scales longer than interannual. The main goals of this study are to help facilitate answers to the above questions by the modification of an existing MJO index and its subsequent analysis and use. Wheeler and Hendon (2004) extracted the slowly eastward propagating MJO signal by developing an index based on the two leading empirical orthogonal functions (EOFs) of the combined fields of the zonal wind at 850 hPa and 200 hPa and the observed outgoing long wave radiation (OLR). The time series of this index is severely limited by the inclusion of the OLR data set which only extends back to June 1974. One of our main goals is the validation of a modified index based on an EOF analysis of the 200 hPa and 850 hPa zonal wind data alone to circumvent the limitation of the relatively short OLR data set, as wind reanalysis data extend back further in time, while keeping the benefit of a high MJO signal extraction. After validating it we use the modified index to examine the MJO and ENSO interaction through various means, such as the phase distribution of the MJO during times of El Niño or La Niña. The behaviour of the MJO on scales longer than the interannual is examined by wavelet analysis, linear trends in MJO activity, and MJO phase distribution climatology.

4D0.5 ID:4866 16:30

Cumulative carbon as a policy framework for avoiding dangerous climate impacts

Damon Matthews [1], *Susan Solomon* [2], *Raymond Pierrehumbert* [3]
[1] Concordia University
[2] National Oceanographic and Atmospheric Administration
[3] University of Chicago
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 an awkward 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. Here, we propose that cumulative carbon emissions represent an alternate framework that is applicable both as a tool for climate mitigation as well as for the assessment of potential climate impacts. We show first that both atmospheric CO2 concentration at a given year and the associated temperature change are generally associated with a unique cumulative carbon emissions budget that is largely independent of the emissions scenario. The rate of global temperature change can therefore be related to first order to the rate of increase of cumulative carbon emissions. However, transient warming over the next century will also be strongly affected by emissions of shorter lived forcing agents such as aerosols and methane. Non-CO2 emissions therefore contribute to uncertainty in the cumulative carbon budget associated with near-term temperature targets, and may suggest the need for a two-basket mitigation approach. By contrast, long-term temperature change remains primarily associated with total cumulative carbon emissions due to the much longer atmospheric lifetime of CO2 relative to other major climate forcing agents.

2D2.2 ID:4868 16:15

The NOAA/FAA/NCAR Winter Precipitation Test Bed: How Well Are We Measuring Snow?

Roy Rasmussen [1], *Bruce Baker* [2], *John Kochendorfer* [2], *Tilden Myers* [2], *Julie Theriault* [3], *Scott Landolt* [3], *Jenny Black* [3], *David Gochis* [3], *Craig Smith* [4], *Alexandre Fischer* [4], *Rodicu Nitu* [4], *Ethan Gutmann* [3]
[1] National Center for Atmospheric Research
[2] NOAA
[3] NCAR
[4] Environment Canada
Contact: rasmus@ucar.edu

Precipitation is one of the most important atmospheric variables for ecosystems, hydrologic systems, climate, and weather forecasting. Despite its importance, accurate measurement remains challenging, and the lack of recent and complete intercomparisons leads researchers to discount the importance and severity of measurement errors. These errors are exacerbated for the automated measurement of solid precipitation and underestimates of 20-50% are common. While solid precipitation measurements have been the subject of many studies, there have been only a limited number of coordinated assessments on the accuracy, reliability, and repeatability of automatic precipitation measurements. The most recent comprehensive study, the "WMO Solid Precipitation Measurement Intercomparison" concluded in 1998 (Goodison et al. 1998) focused on manual techniques of solid precipitation measurement. Precipitation gauge technology has changed considerably in the last 12 years and the focus has shifted to automated techniques. This talk will highlight recent efforts to understand the relative accuracies of different instrumentation, gauges and wind-shield configurations to measure snowfall at the NCAR Marshall Field test bed. This joint collaboration between NOAA, NCAR, NWS, and FAA involves testing new gauges and other solid precipitation measurement techniques in comparison to reference measurements from gauges with large wind shields. This assessment is critical for any ongoing studies and applications such as climate monitoring that rely on accurate and consistent precipitation measurements.

2C6.2 ID:4869 14:15

Evaluation of monthly forecasts of intense winter storms from global forecast models.

Robert Rabin [1], *Hai Lin* [2]
[1] NOAA/NSSL and Cooperative Institute for Meteorological Satellite Studies
[2] Environment Canada, CMC, Dorval PQ
Contact: Rabin@ssec.wisc.edu

The goal of this project is to evaluate the skill in forecasting the climatology of intense winter storms on a monthly or seasonal time scale using global forecast models. Using the output of the second phase of the Canadian Historical Forecasting Project (HFP2), daily hindcasts of sea level pressure (SLP) are compared with the NCEP/NCAR reanalysis over North America for forecasts starting on 1 Dec. of each year. The hindcasts include 10 ensemble members from the GEM forecast model. The probability of an intense storm occurring during 5-day pentads is based on the percent of ensembles forecasting an anomaly in SLP more than 2 standard deviations below the mean SLP. The skill of the forecast will be presented as a function of lead time. If possible, we will attempt to identify the source of skill with respect to low-frequency features such as the Madden-Julian Oscillation and sea surface temperature anomalies.

4D6.1 ID:4870 15:30

"Wind Energy in Canada; the basics, the resource and the opportunity" - making an educational video.

Peter Taylor [1], *Lizz Hodgson* [2], *Rozette Ghadery* [2], *Simone Rapisarda Casanova* [2], *Laurence Green* [2]
[1] York University and Zephyr North Canada
[2] York University
Contact: pat@yorku.ca

With Outreach funding from CFCAS we have produced an educational video reporting on Wind Energy in Canada - Physics, Planning and Politics. It has been a joint venture with York's Film program and a learning experience for all concerned.

A documentary video needs to be somewhat different from a lecture or a scientific paper. Not all of the audience will appreciate the mathematics of the Betz limit, but can we get the concept across? Does a MegaWatt or a Giga-Watt-Hour mean anything to 99% of the population?

Some of the opposition to wind farms seems unfounded scientifically and working within politically determined turbine site limitations has its frustrations. Blending wind with other sources of electrical power will become a more important challenge for wind forecasting, and for some locations icing and its forecasting are important considerations.

Segments of the video will be used to show the type of material we have included in the video.

1P308.1 ID:4872 16:00

Biologically-induced changes in subarctic Pacific surface waters determined from underway dissolved oxygen and nitrogen measurements, 2007 and 2008

Philippe Benoit [1], *Svein Vagle* [2], *Ian Wrohan* [1], *Diana E. Varela* [1]
[1] University of Victoria
[2] Fisheries and Oceans Canada
Contact: pb@uvic.ca

Dissolved air pressure and hydrographic parameters in ocean surface waters were measured from a moving vessel along a track spanning thousands of kilometers from the British Columbia coast (48ºN) to latitudes beyond the Arctic Circle (70º N). Estimates of dissolved N2 concentrations were obtained from simultaneous measurements of gas tension, dissolved O2, water temperature, and salinity collected during the summers of 2007 and 2008. The dissolved N2 concentrations were 1-2% higher in certain regions in 2007 compared to 2008 due to the abnormally warm waters and low wind conditions observed in 2007; particularly in the Bering Sea. A normalized gas saturation ratio δ[O2]/δ[N2] was calculated from the measured parameters to isolate the biological contribution of O2 to surface water O2 saturation levels. The ratio δ[O2]/δ[N2] was larger at higher latitudes and in coastal areas, and was correlated with integrated Chl-a measurements. A series of comparisons between in-vitro productivity measurements and δ[O2]/δ[N2] were obtained for several stations along the 2008 cruise track, and although a strong linear correlation was observed, it remained difficult to relate both datasets without further knowledge of in-situ dissolved O2 growth/decay rates. Future measurements at the same oceanic locales will potentially resolve these issues.

3C0.3 ID:4873 14:15

Dynamics of the lower stratospheric circulation response to ENSO.

Isla Simpson , *Theodore Shepherd* , *Michael Sigmond*

University of Toronto
Contact: isla@atmosp.physics.utoronto.ca

A robust feature of the observed response to anomalies in tropical Pacific sea surface temperatures (SSTs) is a change in temperature of the low latitude lower stratosphere. This consists of a cooling in the tropics and a warming in mid-latitudes for warm ENSO and vice-versa. These temperature anomalies are associated with an anomalous lower stratospheric circulation that can also alter ozone and water vapour concentrations.

Here, the mechanism for production of this low latitude stratospheric circulation response will be investigated with SST perturbation experiments using the dynamical version of the Canadian Middle Atmosphere Model (CMAM). It is found that the anomalous upwelling is predominantly associated with altered resolved wave drag in the southern hemisphere sub-tropical lower stratosphere. It is proposed that the reason for this anomalous wave drag is associated with the altered zonal wind structure in the troposphere. For warm ENSO conditions an acceleration of the sub-tropical jet and an equatorward shifted mid-latitude jet results in improved conditions for vertical wave propagation into the lower stratosphere, related to a quasi-geostrophic refractive index anomaly. The opposite is true of cold ENSO conditions.

This altered wave propagation and drag is only apparent in the southern hemisphere. The difference between the two hemispheres can be related to the difference in their tropospheric zonal wind anomalies which is likely a consequence of the difference in climatological jet structures.

4D3.3 ID:4874 16:15

The 2010 Harrow-Leamington Tornadoes

Mitchell Meredith
Environment Canada
Contact: mitch.meredith@ec.gc.ca

Early in the morning on June 6th, 2010, a long-lived nocturnal supercell storm tracked from Michigan, USA, into southwestern Ontario and directly over southern sections of Essex County including the Municipality of Leamington. The storm was unique due to the occurrence of tornadoes after midnight and the significant advance lead time for the tornado warning. Fortunately, there were no deaths and injuries were minimal.

A damage survey by Environment Canada with help from the University of Western Ontario discovered an almost continuous path of damage over 42 km in length. Post-storm analysis revealed that this path was the result of four tornadoes with F-scale ratings ranging from F0 to F2. One remote barn along the westernmost section of the track was completely destroyed and the main brick farmhouse was shifted on its foundation. In addition, there was extensive downburst damage. Along the main damage path, there was less significant damage in some areas than might have occurred due to cover of mature trees in some residential areas. However, many of the large trees that seemed to protect residences were brought down by tornadic winds, creating indirect damage. Due to the density of structures along the main path, including many industrial greenhouses, there were significant impacts to the community and extensive media coverage for two days following the storm. Some impressive wind and pressure measurements were recorded near the tracks of the tornadoes: maximum wind gust 191 km/h at a 40 metre height and a pressure drop in excess of 25 hPa.

3B0.2 ID:4875 11:00

Impacts of stratospheric ozone depletion on the Southern Ocean and Antarctic sea-ice

John Fyfe [1], *Michael Sigmond* [2]
[1] Canadian Centre for Climate Modelling and Analysis
[2] University of Toronto
Contact: john.fyfe@ec.gc.ca

Using a global coupled atmosphere-ocean-ice model with a well-resolved stratosphere we address three key questions: 1) does the ocean impact the atmospheric response to the ozone hole; 2) has the ozone hole contributed to increased Antarctic sea ice extent?, and 3) what are the separate impacts of decreasing stratospheric ozone and increasing well-mixed greenhouse gases on the Southern Ocean?

2B4.5 ID:4876 11:30

Seasonal variations of tides in shallow waters

Malte Mueller [1], *Josef Cherniawsky* [2], *Mike Foreman* [2]
[1] University of Victoria
[2] Institute of Ocean Sciences
Contact: mmueller@uvic.ca

Ocean tides are varying on seasonal timescales with amplitudes, which are often significantly larger than the implicitly induced variations of the gravitational forcing. Results of a global high-resolution circulation and tide model indicate, that in coastal areas the response of the ocean to the tidal forcing is modulated by changing stratification conditions between winter (well-mixed) and summer (stratified). The amplitude of the seasonal tidal variations are up to 10% and are validated by an analysis of 19 years of satellite data. Further, the physical mechanism behind this effect is discussed by means of simplified one dimensional analytical and numerical models.

4D6.4 ID:4877 16:15

Heavy snowfall of January 2011 in the Columbia region of British Columbia: synoptic overview and impacts on BC Hydro short and long term operations

Tim Ashman [1], *Doug Mccollor* [1], *Greg West* [2]
[1] BC Hydro
[2] BC Hydro/UBC
Contact: timothy.ashman@bchydro.com

Winter season precipitation patterns and resulting snowpack in the BC interior are a large component of water supply for hydroelectric power generation during the following spring, summer, and subsequent seasons. This talk will detail the multi-day snowfall event during the period 12-17 January 2011 that resulted in a significant increase in snowpack across the Columbia region of British Columbia. This snowfall event will be examined synoptically, in context of ENSO, and compared with the relatively quiet winter storm pattern in the months leading up to January 2011. The talk will also detail how the storm affected BC Hydro's short term operations and how it played a role influencing the water supply forecast produced monthly by BC Hydro hydrologists. Heavy precipitation observed at Revelstoke airport on three consecutive days (13-15 January) will also be addressed in the talk, with reference to measurement methods and in context how important quality controlled data is for water supply forecasting as well as other forecast techniques in the energy industry that rely on weather data for calibration, training, and bias correction.

1C1.3 ID:4878 14:45

A case study of diabatic cooling of melting snow during the 2010 Vancouver Olympics

Julie Thériault [1], *Roy Rasmussen* [1], *Trevor Smith* [2], *Mindy Brugman* [2], *Jason Milbrandt* [2], *Ruping Mo* [2], *George Isaac* [2], *Paul Joe* [2], *Jocelyn Mailhot* [2], *Bertrand Denis* [2]
(Presented by *Julie Theriault*)
[1] National Center for Atmospheric Research
[2] Environment Canada
Contact: theriaul@ucar.edu

The occurrence of precipitation types and intensity was critical information required by many of the Olympic venue managers during the Vancouver Olympics. The complex terrain and warm weather conditions in the Whistler area make weather forecasting particularly difficult. The competing influences of warm air advection and diabatic cooling of melting snow were particularly challenging to forecast. The goal of this study is to examine a well-documented case study during the Vancouver 2010 Olympics to demonstrate the impact of the diabatic effect of melting snow on the storm evolution. The case study occurred during the second day of the Olympics when the downhill ski event should have taken place. A rapid cooling was observed at instrument sites experiencing precipitation after about 2200 UTC. Precipitation was reported for 8 hours and led to the creation of a nearly isothermal layer, and a shift of the valley flow from up-valley to down-valley flow towards Squamish. Snow was reported at mid-mountain level and rain at the base of the mountain despite the expectation that large-scale warm advection would maintain temperatures above freezing. The precipitation-induced down-valley flow may act as a secondary cold front that further enhances and prolongs the precipitation. Overall, this case study provides a well-observed example of the competing roles of warm air advection versus diabatic cooling of melting snow on the determination and forecast of precipitation phase in a complex terrain region.

2D2.6 ID:4879 17:15

Relationship between snow gauge collection efficiency and snowflake type

Julie Thériault , *Roy Rasmussen* , *Kyoko Ikeda* , *Scott Landolt*
(Presented by *Julie Theriault*)
National Center for Atmospheric Research
Contact: theriaul@ucar.edu

Accurately measuring solid precipitation is challenging due to a variety of reasons. It has been recognized that systematic errors in snowfall measurements are often observed due to the gauge geometry and the associated weather conditions. For example, the higher the wind speed during a snowfall event, the lower the collection efficiency of the snow gauge. The deflection of the airflow in the vicinity of the gauge will influence the trajectory of precipitation. The different types of snow crystals, which fall at different terminal velocity, may interact differently with the flow around the gauge. To address this, field experiments and a theoretical study were carried out. First, the observed snowflake types are linked to the snow gauge collection efficiency. Second, a theoretical study using 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. Theoretical collection efficiencies for different crystal types were computed and compared with observations. The results illustrate the impact of snowflake type on the snow gauge collection efficiency. The type of snowflake observed helps explain the scatter observed in the collection efficiency for a given wind speed. Overall, this study

demonstrates that fast-falling snowflakes are associated with higher collection efficiency than the slow-falling snowflakes.

1C4.6 ID:4880 15:15

Using polynomial chaos to uncover time dependence of optimal parameter values in a biological ocean model

Jann Paul Mattern [1], *Katja Fennel* [2], *Michael Dowd* [1]
[1] Department of Mathematics and Statistics, Dalhousie University
[2] Department of Oceanography, Dalhousie University
Contact: paul.mattern@dal.ca

High-resolution physical-biological models of coastal ocean regions are becoming increasingly sophisticated and realistic. However, one major difficulty with these models is the need to specify biological parameters, many of which are poorly constrained and not directly observable. Variational methods have been used extensively to identify optimal biological parameters, typically by assuming that parameters are constant in space and time. As an alternative method, we present polynomial chaos, a technique for stochastic models that relates the uncertainty in the model inputs (parameters, initial or boundary conditions) to uncertainty in its outputs. For many stochastic dynamic systems, it can be used as an alternative to Monte Carlo methods, which are often computationally much more costly. We explore the utility of polynomial chaos as a parameter and state estimation technique for a 3D biological ocean model of the Middle Atlantic Bight. Our model is based on the Regional Ocean Modeling System (ROMS) and includes a biological module describing the nitrogen cycle. Using a 1-year dataset of chlorophyll satellite observations of this region, we apply polynomial chaos to estimate the time-dependent model-data distance function. This data assimilation exercise shows that optimal biological parameters are time-dependent and that biological parameters with a seasonal cycle provide better agreement with the observations than the optimal fixed parameter set.

2D5.3 ID:4881 16:45

Bacterial community structure and dynamics in the oxygen minimum zone of the northeast subarctic Pacific Ocean

Jody Wright , *Kendra Mitchell* , *Olena Shevchuk* , *David Walsh* , *Philippe Tortell* , *Steven Hallam*
UBC
Contact: jjwright49@me.com

Seasonal, vertical and geographical patterns in microbial community structure have been observed in many studies of the euphotic regions of the ocean, but these patterns have not been well constrained within interior waters, particularly in the oxygen minimum zones (OMZs) of the global ocean. We discovered vertical and seasonal patterns in bacterial community structure in samples spanning the depth continuum (10-4000m) at Ocean Station Papa (OSP; 50°N, 145°W) located within the worlds largest stably occurring OMZ. Samples were collected between June 2007 and August 2009 aboard the CCGS John P. Tully and analyzed using pyrotag sequencing in combination with ribosomal intergenic spacer analysis (RISA) profiling and small subunit ribosomal rRNA gene (SSU rRNA)-ITS clone libraries to link RISA peaks to cognate bacterial clades. Hierarchical cluster analysis of pyrotag and RISA profiles indicated that while depth remains the most significant predictor of community structure at OSP, distinctive community assemblages exist within the OMZ (500-2000m) at different times of year. Specifically, species richness was highest in February and declined throughout the

spring and summer months when only a few groups were found to dominate the water column. In particular, there was a notable increase in the abundance of SAR11 subgroups from February to August in all OMZ communities (14.6% to 33.4% of total bacterial community). Members of the Marine Group A and the deltaproteobacterial subgroup SAR324 also exhibited seasonal patterns, reaching peak abundance in August. We hypothesize that seasonal changes in bacterial community structure within interior waters are related to changing fluxes of biogenic materials including carbon, nitrogen, silicate and phosphate, which have been shown to exhibit distinct seasonality related to surface water biology, despite this being a high nutrient, low chlorophyll (HNLC) region. Future investigations of seasonal variations in community structure within the OMZ will help resolve the dynamic metabolic capacity of the water column, which is predicted to significantly affect rates of carbon fixation and export to the deep sea as well as nitrogen and sulfur cycling.

2B0.6 ID:4882 11:45

Assessing an Ensemble Optimal Interpolation data assimilation scheme applied to the North Atlantic Ocean

Vasily Korabel [1], *Keith Thompson* [1], *Shiliang Shan* [1], *Frederic Dupont* [2], *Youyu Lu* [3]
[1] Dalhousie University
[2] Meteorological Research Division, Environment Canada
[3] Bedford Institute of Oceanography
Contact: v.korabel@gmail.com

We present an implementation of an Ensemble Optimal Interpolation (EnOI) data assimilation scheme for the North Atlantic Ocean. The scheme is based on the Australian BODAS scheme (Oke et. al. 2008) and uses a seasonally varying error covariance matrix calculated from a long hindcast with realistic atmospheric forcing and spectral nudging of the model's seasonal climatology of temperature and salinity to an observed climatology. The model has a grid spacing of a 1/4 degree and is based on NEMO/OPA. The impact of the assimilation of remotely sensed sea surface temperature and altimeter observations is investigated. We also discuss results using a duo grid formulation which includes a high resolution (1/12 degree) nest that covers the Northeast Atlantic Ocean and adjacent shelf seas.

4C3.3 ID:4883 14:00

Smoluchowski Coagulation Models And Sea Ice Thickness Distribution Dynamics

Daniel Godlovitch
University of Victoria
Contact: dgodlovi@uvic.ca

A sea ice population is composed of ice of a range of thicknesses, many of which are above the limit of thermodynamic growth. The thickness distribution of a population of sea ice usually has an exponential tail. Thick ice is created through the process of ridging, when ice floes are driven together, causing the ice to fracture and pile above and below the surface. Modelling the dynamic evolution of the thickness distribution of sea ice is difficult due to the complex physical properties of the ice.

We present a model of the dynamic evolution of the thickness distribution which represents ridging events in a manner which has many similarities to interactions in Smoluchowski Coagulation Models (SCMs). SCMs have been extensively studied, and are known to produce quasi-exponential populations under a wide variety of formulations. The SCM formalism presents an appealingly simple

and robust tool which may provide a deeper understanding of the processes which drive the statistics of sea ice populations.

1B5.3 ID:4884 12:00

The Amazonian Region: Hot spot of positive carbon-climate feedback in CanESM2 AR5 simulations

Vivek Arora
Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: vivek.arora@ec.gc.ca

The Canadian center for climate modeling and analysis (CCCma) has recently finished several coupled climate-carbon cycle simulations made with its second generation Earth system model (CanESM2) which will contribute results to the upcoming fifth assessment report (AR5) of the IPCC. This talk will focus on the behaviour of the land carbon cycle in the simulations performed for the 2006-2100 period for three future representative concentration pathways (RCPs) of greenhouse gases (RCP 2.6, 4.5 and 8.5). Simulated results for all three scenarios show that the Amazonian region becomes a source of CO2 during 2020s and remains so during the rest of the 21st century. The release of CO2 from this region is due both to the reduction in vegetation as well as soil carbon. While higher CO2 in the RCP 4.5 and 8.5 scenarios, compared to the RCP 2.6, would intuitively be expected to increase the carbon sink (associated with the CO2 fertilization effect) the simultaneous reduction in precipitation with warming, over the region, prevents this from happening. The net result is that the Amazonian region remains a hot spot of positive carbon-climate feedback over most of the 21st century in all three scenarios. High-latitudes regions (where plant productivity is currently limited by temperature), in contrast, accumulate carbon over the 21st century because here the sink in vegetation carbon more than compensates for the losses from soil carbon. The caveat associated with the behaviour of the land carbon cycle in high-latitude regions is that CanESM2 doesn't explicitly model permafrost and peatlands/wetlands are not represented. Reduction in precipitation over the Amazonian region in response to climate warming is generally consistent across most climate models. This would imply that the future of the Amazonian region may look more like the drought of 2005 when the region became a net source of carbon.

2C2.4 ID:4885 15:00

Validation of GOES retrieval algorithms for the detection of fog, visibility and icing conditions

Ismail Gultepe [1], *Mike Pavolonis* [2], *Corey Calvert* [3], *James Gurka* [4], *Randolph Ware* [5], *Janti Reid* [1], *Zlatko Vukovic* [1]
[1] Cloud Physics and Severe Weather Research Section, EC, Toronto, M3H5T4, Canada
[2] NOAA/NESDIS, 1225 W. Dayton St., Madison, WI 53706, US
[3] University of Wisconsin, CIMSS, 1225 W Dayton St., Madison, WI 53706, US
[4] NOAA/NESDIS, GSFC code 417, Greenbelt MD 20771, US
[5] Radiometrics Corporation, 4909 Nautilus Court North, Suite 110, Boulder, CO 80301, US
Contact: ismail.gultepe@ec.gc.ca

The objectives of this work are to develop GOES satellite retrieval algorithms for fog, visibility (Vis) and aircraft icing conditions, and subsequently validating these retrievals against retrievals from in-situ surface observations. The observations were collected during two field campaigns of the Fog Remote Sensing and Modeling (FRAM) project. These took place in St. John's, Newfoundland during Feb 20-April 5 2009 and Yellowknife, NWT during Nov 20 2010-Feb 2 2011, and the conditions observed generally representing warm fog and ice fog conditions, respectively. The Fog Measuring

Device (FMD), Ground Cloud Imaging Probe (GCIP), and Laser Precipitation Monitor (LPM) were the primary instruments used to collect particle microphysical parameters. The measurements of the snow particles and droplets represented the sizes from 2 micron up to a few cm size ranges, and collected at 1Hz sampling rate. Liquid water content (LWC), RH (Relative humidity), temperature (T), vapor mixing ratio (qv), and cloud thickness (Δz) were retrieved from the PMWR observations. The Vis measurements at the surface were collected using the FD12P, Sentry, and SWS200 sensors. Icing regions and time periods were detected using PMWR and Rosemount Icing Detector (RID) indicator at the surface. The GOES-based observations from 5 channels (0.65; 3.9; 6.48; 10.7; and 13.3 micron) were used to estimate fog and icing regions, as well as IFR (Instrumented Flight Rule), and MVFR (Marginal Visual Flight Rule) conditions based on multichannel techniques. In this presentation, validation of GOES based retrievals of fog and icing regions using surface and PMWR measurements will be summarized, and possible future applications for Arctic regions will be discussed.

4B5.2 ID:4886 10:45

Measurement of turbulent large-eddy velocities with a 5-beam VADCP: present results and future promise

Ann Gargett
Institute of Ocean Sciences, Sidney, B.C.
Contact: gargettann@gmail.com

Since 2003, two cabled bottom-mounted deployments of 5-beam VADCPs have been carried out on shallow continental shelves off the coasts of New Jersey and Georgia. An accurately vertical acoustic beam allows direct measurement of the vertical velocity of the energy-containing scales of turbulence. Because they are directly connected to generation processes, the energy-containing scales contain information about these processes, in contrast to the dissipation scales usually reported as “turbulence measurements”, in which all information about generation has been removed by the turbulent cascade. Time-continuous observations of the energy-containing scales have revealed major new insights into the generation mechanisms and the annual cycle of turbulent processes in the two cabled locations. I will document two new discoveries: (1) full-depth Langmuir circulations that are the main annually-averaged sediment transfer mechanism on the inner New Jersey shelf, and (2) persistent nocturnal convection throughout the year at mid-shelf off Georgia. The question of the spatial footprint of the single-point times series observations will be addressed. New methods of analyzing turbulence in the (normal) oceanic case of time-variable mixed forcings will be demonstrated, as will the feasibility of two alternate methods of deploying VADCPs to measure turbulence in the ocean, a two-stage towed platform and a subsurface mooring.

1B1.2 ID:4887 11:30

Uncertainty in measurements collected at the RND site the during SNOW-V10 Project

Ismail Gultepe [1], *George Isaac* [1], *Paul Joe* [1], *Jason Milbrandt* [2]
[1] EC, Cloud Physics and Severe Weather Research Section, Toronto, ON M3H5T4
[2] Recherche en prévision numérique, Environment Canada, Dorval, Quebec, Canada
Contact: ismail.gultepe@ec.gc.ca

The objective of this work is to better evaluate the uncertainties in the measurements collected at the RND (Roundhouse) meteorological station, located at an elevation of 1856 m, near Whistler, BC, during the Science of NOwcasting Winter Weather for the Vancouver 2010 Olympics and

Paralympics (SNOW-V10) project that was supported by the Fog Remote Sensing and Modeling (FRAM) 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, but data collection started one year before the games and continued to the end of summer 2011. Observations of visibility (Vis) from the FD12P, Sentry, and HSS sensors, precipitation rates (PR) and types from FD12P, GEONOR, Laser Precipitation Monitor (LPM) and OTT Parsivel distrometers, and total precipitation sensor (TPS), temperature (T) and relative humidity with respect to water (RHw) from the capacity sensors, winds with 2D-1Hz and 3D-8 Hz sampling rates from Young anemometers, and SW and IR radiative fluxes from radiometers were collected during the project and used in the analysis.

Preliminary results suggested that differences among Vis2 m s-1. In this presentation, i) uncertainties in the measurements and confidence intervals, and ii) the impact of these uncertainties on model based comparisons will be summarized.

1C1.5   ID:4888   15:15

Snow particle spectra from FMD, GCIP, SVI, and distrometers measurements collected at the RND site during SNOW-V10 Project

Ismail Gultepe [1], *Paul Kucera* [2], *George Isaac* [1], *Zlatko Vukovic* [1], *Roy Rasmussen* [2], *Jason Milbrandt* [3], *Paul Joe* [1]
[1] EC, Cloud Physics and Severe Weather Research Section, Toronto, Ontario, Canada
[2] Research Applications Laboratory, National Center for Atmospheric Research, Boulder, Colorado, USA
[3] Recherche en prévision numérique, Environment Canada, Dorval, Quebec, Canada
Contact: ismail.gultepe@ec.gc.ca

The objectives of this work are i) to obtain an integrated snow particle spectra and ii) use it for estimating visibility (Vis), reflectivity (Z), Precipitation Rates (PR), and Snow water content (SWC) representing mountain winter conditions. Observations were collected at the RND (Roundhouse) meteorological station located at an elevation of 1856 m during the Science of NOwcasting Winter Weather for the Vancouver 2010 Olympics and Paralympics (SNOW-V10) project that was supported by the Fog Remote Sensing and Modeling (FRAM) 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. The Fog Measuring Device (FMD), Ground Cloud Imaging Probe (GCIP), Snow Video Imaging (SVI) camera system, and Laser Precipitation Monitor (LPM) and OTT Parsivel distrometers were used in the analysis. The measurements of the snow particles represented sizes from 2 microns up to a few cm size ranges. In this presentation, results related to i) integrated snow particle spectra, ii) application to Vis, PR, and Z calculations, and iii) earlier studies will be given and application to models will be discussed.

1P308.5   ID:4889   16:00

A Hindcast Experiment for the Kuroshio-Oyashio region based on Regional Ocean Modeling System (ROMS)

Hiroshi Kuroda [1], *Takashi Setou* [1], *Shigeho Kakehi* [2], *Shin-ichi Ito* [2], *Tomonori Azumaya* [3], *Manabu Shimizu* [1], *Tomowo Watanabe* [1]
[1] National Research Institute of Fisheries Science
[2] Tohoku National Fisheries Research Institute
[3] Hokkaido National Fisheries Research Institute
Contact: kurocan@affrc.go.jp

We conduct a hindcast experiment (1986-2007) based on ROMS for the Kuroshio-Oyashio region around Japan to comprehend its capability and reproducibility prior to developing an operational ocean forecast system. 1/2- and 1/10-degree models are connected by one-way nesting, covering almost the whole of the North Pacific and the Western North Pacific, respectively. This study focuses on results from the latter eddy-resolving model, which can successfully simulate the following oceanographic features; the transport of the Kuroshio through East China Sea, Ryukyu Current appearing to the east of East China Sea, the Kuroshio south of Japan, the Kuroshio Extension (its first and second trough or crest), the Oyashio First and Second Branch, and the Mixed Water Region between the Kuroshio Extension and subarctic current. Moreover, this model can reproduce two stable modes of the Kuroshio such as the Large Meander (LM) and Non-Large Meander (NLM) as well as two substable paths such as nearshore and offshore NLMs. Transition from the NLM to LM appears realistically reproduced, that is, a trigger small meander propagates eastward along the Kuroshio south of Japan and develops into the LM. In contrast, reverse transition from the LM to NLM is not easy to realistically simulate. The simulated typical transition can be described as follows. A large cold eddy related to the LM is detached southward, propagates westward, again contacts the Kuroshio in the upstream region, where the cold eddy is absorbed into the Kuroshio, and finally the LM is finished. The simulated transition dynamics is further examined.

1P504.3 ID:4890 16:00

Flow Pathways through the Canadian Arctic Archipelago

Qiang Wang , *Paul G. Myers* , *Xianmin Hu* , *Andrew B.g. Bush*
Department of Earth and Atmospheric Sciences, University of Alberta
Contact: qw4@ualberta.ca

The Canadian Arctic Archipelago (CAA) is a complex network of straits and basins connecting the Arctic Ocean and the Atlantic Ocean. It is one of the main pathways for freshwater outflow from the Arctic Ocean to the Atlantic Ocean. In our talk, we analyze the flow pathways through the CAA using a pair of numerical models of the CAA and the Arctic. The model results of ocean circulation in the CAA are in agreement with observed features. The water flows southward in M'Clintock Channel as a result of the topographic steering and conservation of potential vorticity. The intrusion of the Baffin Current in eastern Lancaster Sound is well simulated and the model results show that the stratification has strong impact on the circulation in eastern Lancaster Sound.

1C0.3 ID:4891 14:45

The influence of Synoptic Weather Conditions on Weekday-Weekend Effect of Extreme Ground-level Ozone Events in the Toronto area, Canada

Kinson Leung , *William Gough*
University of Toronto: Department of Physical and Environmental Sciences
Contact: kinson.h.leung@gmail.com

The 2000 to 2008 weekday-weekend variations of ozone concentration were examined in relation to the concurrent weather conditions/air masses of the Toronto area. The goal of this work is to determine whether the extreme ground-level ozone events were associated with specific weather conditions/air masses. The results show that during the study period, there were a total of 313 days (about 2.38% out of the whole study period) listed as days having an extreme ground-level ozone event with the O3 concentration ≥ 80 ppb, which is the current Ontario Ambient Air Quality criterion for extreme ozone concentration, in the four selected Toronto sites. In addition, the weather

condition/air mass mainly associated with these 313 days was found to be Dry Tropical. As well, when the ozone-concentration settings were changed incrementally from ≥ 80 ppb to ≥ 20 ppb, the dominant weather condition/air mass within each setting changes as well. However, the Dry Moderate and the Dry Tropical were the two most dominant weather conditions among all the settings of O3 concentrations in the nine-year study period.

4C1.3 ID:4892 14:30

A History of Climate Model Development at CCCma

Gregory Flato , *John Scinocca*
Canadian Centre for Climate Modelling and Analysis
Contact: greg.flato@ec.gc.ca

There are relatively few global climate modelling centres in the world, and most are rather larger than the Canadian Centre for Climate Modelling and Analysis (CCCma). Nevertheless, versions of the CCCma climate model have been prominent in high-profile reports such as the IPCC Scientific Assessments. In this talk, we will present a brief history of model development at CCCma, noting in particular the core contributions of George Boer and Norm McFarlane. The survey will begin with the early atmosphere-only model that launched the climate model development effort and whose spirit persists in the model being run today. We will then trace the history through initial coupling of the atmosphere to an upper-ocean model, to the development of a fully three-dimensional atmosphere ocean model, and finally to the present-day Earth System model. Important results from these models will be highlighted along the way, as will the importance of careful, methodical testing and development, and the 'golden vision' that has guided progress.

1B5.2 ID:4893 INVITED/INVITÉ 11:30

The Second Generation Canadian Earth System Model (CanESM2): An Overview

Gregory Flato
Canadian Centre for Climate Modelling and Analysis
Contact: greg.flato@ec.gc.ca

An Earth System model goes beyond a conventional coupled global climate model by including representations of important biogeochemical processes that feedback directly on the physical climate. Of particular note are representations of the carbon and sulphur cycles. The former directly affects the extent to which carbon dioxide, emitted by human activities, is taken up by the land and ocean, and hence affects the amount remaining in the atmosphere and altering the radiative budget. The latter directly and indirectly affects the energy budget by altering the amount of sulphate aerosols in the atmosphere. This presentation will provide an overview of CanESM2 and a survey of results obtained from both historical simulations and future climate projections. In particular, we will show results comparing historical simulations to observations, allowing evaluation of model performance, and will discuss how the future projections differ from those made with earlier climate models. The development of CanESM2 represents the culmination of many years of work by a large group of scientists at CCCma, along with university colleagues who have been involved in various research networks. The results from this model constitute the core Canadian contribution to the multi-model ensemble that will underpin the IPCC Fifth Assessment Report.

4C1.1 ID:4894 INVITED/INVITÉ 13:30

On the role of statisticians and the study of predictability

Francis Zwiers
Pacific Climate Impacts Consortium
Contact: fwzwiers@uvic.ca

George Boer is the architect of the ongoing internationally regarded effort to understand and model the climate system at Environment Canada (EC). Part of George's success, reflected in the legacy that he built, is his wide range of interests. These range from the fundamental dynamical processes of the climate system, to the dynamical and statistical underpinning of predictability on seasonal to decadal time scales, to the role of the carbon cycle in the long term evolution of the system in response to anthropogenic forcing. In developing EC's capability to undertake climate modelling, George has been an exemplary mentor, engaging with young scientists and encouraging them to pursue excellence and rigour as he himself has done throughout his career. Part of George's success includes creative and insightful risk taking, such as the risk that he took in the early 1980s when hiring a young scientist with a background in the statistical sciences as part of his small, developing climate modelling and analysis team. George understood, well before many others, that the application of statistical concepts is a key component of the study of climate. George's dedication, influence, and appreciation for the role of statistical reasoning as an adjunct to physical reasoning contributed to the development of an effective seasonal forecasting capability, the implantation of a rigorous and disciplined scientific approach for managing the evolution of that system, the adoption of international experimental protocols for the assessment of seasonal predictability, and the quantification of the potential for decadal predictability. In pursuing this path, George also inspired scientists in his group to investigate statistical approaches for wringing as much predictability from dynamical seasonal forecasts as possible. In this talk I will review some important aspects of the work on seasonal to decadal predictability to which George has contributed so influentially.

1B5.1 ID:4895 INVITED/INVITÉ 11:00

The IPCC 5th Assessment Report

Francis Zwiers
Pacific Climate Impacts Consortium
Contact: fwzwiers@uvic.ca

The preparation of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5) is now well underway. Many new comprehensive Earth system models including both physical and biogeochemical processes have been developed as have new forcing scenarios, and ambitious new climate model Intercomparison projects are being carried out. In this talk I will describe the IPCC process, the structure of the new reports that are in development, the supporting climate modelling experiments, the forcing scenarios that are being used to drive the new models, and some of the preparations for the process that have been undertaken by the IPCC's working groups. The IPCC process combines an exhaustive assessment of a broad and expanding science with an extensive multistep review process and engages governments in a manner that allows them to take ownership of the document that is produced. This combination of science, expert and government review, and ultimate government approval and acceptance provides a basis for policy making that is unparalleled in any scientific endeavour. While the IPCC has been buffeted by recent events, numerous evaluations have demonstrated the fundamental soundness of the process and its conclusions. Furthermore, the enthusiastic participation of the scientific community in the process and the ongoing engagement of world governments demonstrate the continuing relevance of the IPCC and the information that it provides.

3B1.6 ID:4896 11:45

Using graphical processing units to speed up numerical weather prediction

Thomas Nipen , *Roland Stull*
University of British Columbia
Contact: tnipen@eos.ubc.ca

Graphical processing units (GPUs) are massively parallel computing devices whose use has recently been explored in numerical weather prediction (NWP). Their parallel floating-point capabilities match well with the inherently parallel nature of NWP calculations and can result in significant computational speed-up compared to conventional processors.

We analyse a collection of commonly found algorithmic patterns in the Weather Research and Forecasting (WRF) model for their speed-up potential on GPUs. The speed-up of a component of the model (using a particular algorithmic pattern) depends on many factors, such as its arithmetic intensity, stencil size, and the number of variables involved in the calculation. The major components of the WRF-ARW dynamical core such as advection, Coriolis and curvature effects, diffusion, and diagnostic calculations, as well as a microphysics and radiation scheme are analysed for their GPU speed-up potential. This analysis of speed-up potential of various algorithmic patterns can be applied to other NWP models such as GEM.

1C6.1 ID:4897 14:00

Extreme events and natural disturbances in northern British Columbia

Vanessa Foord [1], *Hardy Griesbauer* [2], *Craig Delong* [1]
[1] British Columbia Ministry of Natural Resources Operations
[2] Independant Consultant
Contact: Vanessa.Foord@gov.bc.ca

Understanding the relationship between extreme weather and climate events and natural disturbances has become increasingly important for natural resources industries planning for climate change. To increase adaptive capacity and manage risk in these industries, knowledge of the relationship between extreme events and natural disturbances is required. We are currently using historical information to assess the future risk of forest pests and diseases, fire, drought, floods, and landslides in northern British Columbia. Creating relationships using historical data is key to making future predictions as many climate triggers of such disturbances are unknown. We have conducted a baseline analysis of temperature and precipitation extremes using instrumental weather data and have compiled information from natural disturbances databases looking for trends. We will use existing climate modeling tools to predict risk of future disturbances based on the relationships developed.

1B2.5 ID:4898 12:00

Eureka Weather Station Operational Logistics

Ken Wowryk
Meteorological Service of Canada
Contact: KEN.WOWRYK@EC.GC.CA

This presentation will concern the main logistical requirements of the Eureka Weather Station to support the atmospheric monitoring programs as well as research at Eureka and the High Arctic in general. Much of what is required logistically for this site is unique for Environment Canada. Items discussed will include the annual marine resupply by the Canadian Coast Guard and the monthly fresh produce and personnel air charter. Facility infrastructure items will also be discussed including electrical power generation, fresh water supply and waste water disposal, airfield use and maintenance as well as other day to day requirements.

4D0.1 ID:4899 INVITED/INVITÉ 15:30

An overview of the effects of historical land cover change on climate and the carbon cycle

Julia Pongratz [1], *Christian Reick* [2], *Thomas Raddatz* [2], *Martin Claussen* [3], *Ken Caldeira* [1]
[1] Carnegie Institution, Department of Global Ecology
[2] Max Planck Institute for Meteorology, Hamburg, Germany
[3] Max Planck Institute for Meteorology, Hamburg, and KlimaCampus, University of Hamburg, Germany
Contact: pongratz@stanford.edu

Anthropogenic land cover change (ALCC) is the second-largest source of anthropogenic greenhouse gas emissions, but its effects on atmospheric CO2 and climate are less well understood than those of fossil-fuel burning. First, ALCC may have changed the atmospheric CO2 concentration starting long before the industrial era, which requires knowledge of the preindustrial land cover distribution and the fate of early CO2 emissions. Second, ALCC affects climate not only via the carbon cycle, but also by changing the physical properties of the land surface. By increasing the surface reflectivity, ALCC may have cooled, not warmed the climate. To investigate the contribution of ALCC to past and present changes in atmospheric CO2 and climate we perform transient simulations from the year AD 800 to present day with a comprehensive climate model that includes the closed, interactive carbon cycle. We apply a detailed global land cover reconstruction. We find that historical ALCC has caused CO2 emissions of about 160 GtC, one third of them prior to 1850. Emissions are largely mitigated by a strong land sink in the preindustrial era, but an early human impact on atmospheric CO2 is detectable: ALCC increased CO2 by 5-6 ppm by the end of the preindustrial era, and by 20 ppm today. The trend towards higher CO2 is only slightly offset by regional carbon uptake in regrowing trees during wars and epidemics. We simulate global mean temperature to increase by 0.18 K in the 20th century due to the carbon cycle effects of ALCC. Biophysical effects have a small impact on global mean temperatures of -0.03 K in the 20th century. Our simulations suggest that the climate response to ALCC is dominated by the rise in CO2, which has started its upward trend long before the industrial era.

4B3.1 ID:4900 10:30

Long Term Variability of the Kuroshio Transport East of Taiwan and the Climate it Conveys

Mao-Lin Shen [1], *Yu-Heng Tseng* [1], *Sen Jan* [2], *Chih-Chieh Young* [1], *Ming-Da Chiou* [2]
[1] Department of Atmospheric Sciences, National Taiwan University
[2] Institute of Oceanography, National Taiwan University
Contact: earnestshen@gmail.com

The Kuroshio Transport (KT) from 1993 to 2010 was established using satellite altimetry data through three different methods: geostrophic relationship (GR), empirical relationship (ER) and transfer function (TF). The relationships were constructed on the observed KT from the World Ocean Circulation Experiment (WOCE) moored current meter array east of Taiwan (i.e., PCM-1) and its surrounding Sea Surface Height (SSH) difference. These methods and the associated characteristics were verified by the ten years climatology model simulations of the KT for long term applications. The GR cannot well represent the high frequency variability of KT (< two months). The KT established by ER has a similar temporal variation to the GR but smaller variance. The TF can establish observed signals covering all available frequencies. However, the PCM-1 data period is not long enough to build an appropriate TF with small variance for long term applications. We then analyzed the long term variability of the KT on PCM-1 Section based on GR and TF approaches. It was found that the annual-averaged KT was mainly controlled by the northern branch of the North Equatorial Current (NEC) and mesoscale eddies generated from the Subtropical Counter Current (STCC) while the NEC is strongly influenced by the ENSO events, and the mesoscale eddies are related with the West Pacific (WP) teleconnection pattern.

1P308.2 ID:4901 16:00

Model simulated variations of meso-scale eddy activity near the Tail of the Grand Banks

Yuehua Lin [1], *Youyu Lu* [2], *Keith Thompson* [1], *Frederic Dupont* [3], *Jinyu Sheng* [1]
[1] Dalhousie University
[2] DFO, Bedford Institute of Oceanography
[3] Environment Canada
Contact: Yuehua.Lin@phys.ocean.dal.ca

The North Atlantic Current and Labrador Current interact near the Tail of the Grand Banks. The strong eddy kinetic energy (EKE) in this region has been inferred from sea surface height observed with satellite altimeters, and is reproduced with a nested eddy-resolving model based on Nucleus for European Modelling of the Ocean (NEMO). Frequency-dependent empirical orthogonal function (FEOF) analysis shows that both the modelled and observational EKE fields vary predominantly as standing modes in the area. The strong EKE near 43˚N is related to eddies crossing the front between the Labrador Current and North Atlantic Current. The rates of energy transfer from the mean flow to eddies through baroclinic and barotropic instability are diagnosed from the model solutions. Significant correlation is found between interannual variability of the EKE and the energy transfer due to baroclinic instability. The cause of the interannual variability of baroclinic instability, and hence the EKE, in this region is discussed.

3B2.5 ID:4902 11:45

Affect of climate changes on long-term river flow fluctuations

Anatoly Frolov
Water Problems Institute, Russian Academy of Sciences
Contact: AnatolyFrolov@yandex.ru

The problem of estimating long-term variations in river runoff statistical parametersfor various quasi-stationary climatic conditions is considered. This problem requires the application of physically based models of river flow in which the models are assumed to be invariant to climatic change. In other words, it is assumed that the model reproduces characteristics of river runoff for "past" climate and is expected to also yield acceptable results for the "new" climate. At present, the impact of climate

change on long-term fluctuations in river runoff can be estimated only as mean values over 20-30 years. However, the operations of many water projects depend not only on the mean river flow but also on other statistical properties of the long-term flow fluctuations, including the coefficient of variation, asymmetry, and autocorrelation. Estimates of these parameters for future climatic conditions are of high practical importance. The main approach in modeling long-term variations in river runoff is based on the watershed model developed by Vit Klemes (Canada). Following this approach, we formulated a linear reservoir model with two input non-Gaussian processes and obtained analytical expressions which relate statistical characteristics of the river flow to the parameters of precipitation and evaporation over a watershed. These expressions enable us to examine the sensitivity of the river-flow statistical propertiesto changes in the governing parameters of the water balance over the watershed, namely, to the rainfall and evaporation. We have formulated the dynamical stochastic models of long-term river flow fluctuations for three rivers, the Volga, Northern Dvina, and Fraser. Our findings show that variations in river flows are more sensitive to changes in the variance of precipitation than of evaporation. Other important statistical characteristics of the river runoff have been obtained as functions of the statistical characteristics of precipitation and evaporation.

1P605.1 ID:4904 16:00

Overview of Snowflake Observations from Two Locations using the Snowflake Video Imager (SVI)

Paul Kucera [1], *Larry Bliven* [2]
[1] National Center for Atmospheric Research
[2] NASA/Wallops Flight Facility
Contact: pkucera@ucar.edu

The natural variability of frozen precipitation is a complicating factor for remote sensing studies in high latitude regions. Particle classification is important for understanding snow/ice physics, bulk radiative properties, and surface emissivity. The particle size distributions (PSDs) along with information about the particle type combined with other measurements provide estimates of the density and snow water equivalent of the falling snow. In an attempt to provide better observations of precipitation particles, NASA has developed an instrument called the Snowflake Video Imager. SVIs are a vital tool because they continuously record 8-bit gray-scale images at 55-60 frames per for long periods of time (e.g., for an entire winter season). Particle images are analyzed, aggregated, and cataloged into one-minute intervals using NASA's Precipitation Link Software that produces (a) Particle Catalogues and (b) Particle Size Distributions (PSDs). During the winter of 2009-2010, an SVI was deployed in SNOWV10 in support of the winter Olympics. The SVI was located on Whistler Mountain at the Roundhouse site. The SVI operated almost continuously from 25 January 2010 through 15 April 2010. Approximately 11 million snowflakes were recorded during that period. These particles were processed and Particle Catalogue and the PSDs were generated for SNOWV10. A SVI has been in operation at the NCAR Marshall Field Site located near Boulder, CO since 2007. The deployment at the Marshall Field Site provides a relatively long record of particle types and PSDs. The presentation will give an overview of the SVI along with a comparison of observations collected during SNOWV10 with the longer term observations collected at the Marshall Field Site.

1C5.3 ID:4905 14:30

Annual cycle of ocean heat transport and its projected changes

Duo Yang , *Oleg Saenko*

Environment Canada - CCCma
Contact: duo.yang@ec.gc.ca

Studies show that the seasonal cycle of wind stress drives the seasonal cycle of ocean heat transport, which is governed by a relatively simple set of dynamics as opposed to the time-mean heat transport; that is, the time varying wind stress drives the anomalies in the Ekman layer mass transport which are compensated by barotropic return flows. Would the dynamics hold under the different, warmer climates? Would the seasonal cycle of ocean heat transport change? To address these questions the historical run (1850-2005) and two scenario runs, RCP4.5 and RCP 8.5 (2006-2100), from CanESM2 (the 2nd version of the Canadian Earth System Model) have been analyzed, and the results will be presented.

2B4.2 ID:4906 10:45

Modeled Patterns of Regional Sea Level Rise around Taiwan

Chih-Chieh Young , *Yu-Heng Tseng* , *Mao-Lin Shen*
Department of Atmospheric Sciences, National Taiwan University
Contact: youngjay@ntu.edu.tw

Regional sea level rise in the vicinity of Taiwan is numerically investigated using the newly developed parallel free-surface global ocean model (TaIwan Multi-scale Community Ocean Model, TIMCOM). Model results indicate that the pattern of regional sea level rise has a non-uniform distribution in space. The predicted time series of surface elevation is analyzed by linear regression and nonlinear smoother approaches, obtaining the long-term trend of regional sea level rise. Interannual variations play a key role in the seal level pattern of the studied areas. The overall results are consistent with those observed in the previous studies primarily using tide-gauge and satellite altimetry data. The relation between the sea surface height and the upper-water temperature anomaly is established, supporting that thermal expansion of sea water dominates the sea level variation around Taiwan. Finally, the model predicts future sea level changes under different scenarios, which are essential for effective risk assessment. Model predictions and potential threats to Taiwan are discussed.

Keywords: sea level rise, global ocean model, linear regression, nonlinear smoother approach, decadal oscillation

2D5.2 ID:4907 16:30

Nitrous oxide production in the sub-oxic waters of the NE Pacific

Damian Grundle [1], *Roxane Maranger* [2], *Kim Juniper* [1]
[1] University of Victoria
[2] University of Montreal
Contact: dgrundle@uvic.ca

The expansion of marine hypoxic zones may lead to a significant increase in the production of nitrous oxide. The two principle processes involved in the production of this greenhouse gas in the ocean are nitrification and denitrification. Denitrification is typically restricted to O2 concentrations less than ~0.25 ml L-1 and the nitrous oxide produced via this pathway is subsequently consumed during reduction to dinitrogen. Nitrification is therefore the dominant process by which net accumulations of nitrous oxide arise in the ocean. Several studies have demonstrated that the nitrous oxide yield from laboratory cultures of marine nitrifying bacteria increases as oxygen concentrations decrease below

~2.0 ml L-1. These findings indicate that the global production of nitrous oxide will grow with increasing occurrences of hypoxia. The global greenhouse effect of atmospheric nitrous oxide over the next century is expected to be ~350 times higher than that of carbon dioxide. Any increase in nitrous oxide therefore has important implications for atmospheric temperatures and may lead to feedbacks which further the expansion of hypoxic zones. In order to accurately predict future atmospheric nitrous oxide concentrations and identify possible feedbacks, we must first improve our understanding of the effect of reduced oxygen concentrations on nitrous oxide production at regionally specific scales. This presentation examines the potential for in situ nitrification to produce higher amounts of nitrous oxide under reduced oxygen conditions in the NE Pacific. Our projections will be based on measurements of delta nitrous oxide, from the surface to the sub-oxic zones of oceanographic sampling stations along Line P.

1B6.2 ID:4908 11:15

Extreme cold winter temperatures in Europe under the influence of atmospheric blocking

Jana Sillmann [1], *Mischa Croci-Maspoli* [2], *Malaak Kallache* [3], *Richard W. Katz* [4]
[1] University of Victoria
[2] MeteoSwiss, Switzerland
[3] Climpact, France
[4] NCAR, USA
Contact: jana.sillmann@ec.gc.ca

Atmospheric blocking conditions over the North Atlantic explain parts of the winter climate variability in Europe and are associated with anomalous cold winter temperatures. Thus we use atmospheric blocking conditions as covariate in the statistical modelling of extreme cold winter temperatures. In this study, the Generalized Extreme Value distribution (GEV) is fitted to monthly minima of European winter minimum surface temperatures obtained from ECHAM5/MPI-OM global climate model simulations and ERA-40 re-analysis. We demonstrate that relating the location and scale parameter of the GEV linearly to atmospheric blocking improves the fit to minimum temperatures in large areas of Europe. The climate model simulations agree well with the ERA-40 re-analysis in the present climate (1961-2000). Under the influence of atmospheric blocking, a general shift in the extreme minimum temperatures to lower values can be distinguished. This ``cooling effect'' of atmospheric blocking is however diminished in future climate simulations due to a decrease in blocking frequency and thus reduces the chances of very cold winters in Europe.

3P407.3 ID:4909 15:30

Seasonal variations of organic-walled dinoflagellate cyst production in the Santa Barbara Basin: implications for paleoenvironmental reconstructions and harmful algal blooms

Manuel Bringué , *Vera Pospelova*
School of Earth and Ocean Sciences, University of Victoria
Contact: mbringue@uvic.ca

A fortnightly sediment trap record spanning from May 1995 to March 1997 provides insights on the production of organic-walled dinoflagellate cysts in the highly productive waters of the Santa Barbara Basin (SBB), offshore Southern California. The trap was deployed at 538 m depth, in the oxygen-depleted bottom waters. Marine productivity in the SBB is greatly influenced by wind-driven coastal upwelling, particularly intense from spring to early summer. During periods of active upwelling, dinoflagellate cyst export to the bottom waters are higher (up to 239,696 cysts.m^{-2}.day^{-1}) compared to conditions of highly stratified, nutrient depleted surface waters (˜ 60,000 cysts.m^{-2}.day^{-1}). Our data

reveal that the assemblages are dominated by cysts of heterotrophic dinoflagellates *Brigantedinium* spp. (overall relative abundance of 62.4 %) and *Echinidinium* spp. (13.7 %). In total, 50 dinoflagellate cyst taxa are identified. Preliminary analyses show that taxa associated with active upwelling conditions (low sea-surface temperature and high salinity, nutrient and biogenic silica concentrations) include *Brigantedinium* spp., *Quinquecuspis concreta*, *Echinidinium* spp. and *Dubridinium* spp. Taxa that correlate with high sea-surface temperature are *Echinidinium granulatum* and *Polykrikos schwartzii* sensu Matsuoka et al. 2009. Potentially toxic dinoflagellate species have been recovered in both thecal (e.g., *Prorocentrum micans*, *Lingulodinium polyedrum*) and encysted forms (*Lingulodinium machaerophorum*). The latter accounts for 5.0 % of the total assemblage and is associated with post- (relaxed) upwelling conditions. *Prorocentrum micans* fluxes exceed 80,000 thecae m^{-2} day^{-1}, typically in association with highly stratified, nutrient-depleted waters. These results have important implications for reconstructing the climate history of the SBB, including past El Niño events. They will be used as a basis for interpretation of down-core variations in a sequence of varved sediments from the Santa Barbara Basin.

2B3.5 ID:4910 11:30

Air quality forecasting by neural networks and support vector regression based on feature selection by mutual information

Johannes Jenkner [1], *William Hsieh* [1], *Alex Cannon* [2]
[1] University of British Columbia
[2] Meteorological Service of Canada
Contact: whsieh@eos.ubc.ca

Many prediction problems, including air quality forecasting, suffer from the high dimensionality of the input or feature space, which makes it necessary to pre-select relevant features as predictors. Traditionally, forward selection algorithms pick one feature after the other until a termination criterion is met and the selection is completed.

In our approach, a forward selection is configured to identify useful predictors for nonlinear regression analysis using Bayesian neural networks (BNN) and support vector regression (SVR). Candidate predictors are evaluated based on their (a) correlation and (b) mutual information with the predictand. Accordingly, the setup (a) only detects linear relations whereas (b) also detects nonlinear relations with the predictand. In each iteration step of the selection, a simple kernel regression analysis is undertaken. The next iteration step then continues with the residual of the predictand, i.e. without the influence of the previously selected predictor.

The efficiency of the forward selection is evaluated in a test bed consisting of several air quality variables (ozone, coarse particulate matter PM10, CO, NO, NO_2 and NO_x) and meteorological variables measured hourly at two stations near Rome, Italy. The two setups (a) and (b) are run separately, with the selected predictors then used by BNN and SVR. Different termination criteria are applied and the results are also compared to an analysis using all features as predictors. The final rating is done based on skill scores in both the physical and the probability spaces, i.e. based on the mean squared error/mean absolute error and the linear error in probability space (LEPS) score, respectively. Our ozone concentration forecasts attained the top score in the AMS 2011 Artificial Intelligence Forecasting Contest.

4C2.4 ID:4911 14:30

Validation of statistical downscaling methods in terms of weather and climate: Surface temperature in Southern Ontario and Quebec

Carlos F. Gaitan [1], *William W. Hsieh* [1], *Alex J. Cannon* [2], *Philippe Gachon* [2]
(Presented by *Carlos Gaitan Ospina*)
[1] University of British Columbia
[2] Environment Canada
Contact: cgaitan@eos.ubc.ca

NCEP/NCAR reanalysis inputs were downscaled using linear and nonlinear machine learning/statistical methods, namely multiple linear regression and Bayesian neural networks, to obtain daily station values of maximum temperature (TMAX) and minimum temperature (TMIN) for 10 weather stations located in Southern Quebec and Ontario. Mean absolute errors (MAE) between the downscaled data and the observations were used to determine the models' performance in simulating day by day variability (i.e. ”weather”), while MAEs calculated from the STARDEX climate indices (which provide annual statistics for extreme weather) were used to determine the performance in simulating longer time scale variability (i.e. ”climate”). The results show that although the linear models can successfully model daily temperature variations, the nonlinear models usually outperform their linear counterparts in terms of the climate indices. The validation methodology also suggests that the final users should select downscaling models based on their particular needs, as the best models for representing daily variability need not necessarily be the best at simulating the climate of extremes, such as heat wave duration, number of frost days in a given year, growing season length, etc.

1P502.1 ID:4912 16:00

Parallel domain-decomposed Eddy-Resolving model Taiwan Multi- scale Community Ocean Model

Mu-hua Chien , *Yu-heng Tseng*
National Taiwan University, Dept. of Atmospheric Science
Contact: r99229010@ntu.edu.tw

Parallel Domain-decomposed TaIwan Multi-scale Community Ocean Model (PD-TIMCOM) has been developed to provide a flexible and efficient community ocean model for simulating a variety of idealized and real ocean flows over a wide range of scales and boundary conditions. The model particularly targets at resolving multi-scale dynamics in the ocean environment, from small scale turbulence to the global circulation gyres. Thenovel parallel algorithmimproves the efficiency of the Error Vector Propagating (EVP) method,a simple direct solver for the typical pressure Poisson equationsin the PD-TIMCOM. The new approachis ideal for multiple processes and takes the advantage of parallel domain decomposition, which can significantly reduce the computational counts and memory shortage simultaneously. Therefore, this improvement makes that PD-TIMCOM afford the eddy-resolving resolution and apply to the future climate projection. We illustrate the parallel performance based onthe 1/4° and 1/16° global adaption of PD-TIMCOM.Our results show accurate quasi- equilibrium large-scale energy transport, such as thermohaline circulation, and meso-scale variability, reasonably separation of several western boundary currents, Kuroshio-Oyashio extension and Gulf-stream.

1P406.1 ID:4913 16:00

The Influence of Solar Variability on the Atmosphere and Ocean Dynamics

Pei-Yu Chueh , *Yu-Heng Tseng*
Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan
Contact: r98229016@ntu.edu.tw

The sun is well-known as the fundamental energy source that drives the global climate system. It has been suggested that the 11-year cycle of solar forcing is associated with various phenomena in both atmosphere and ocean from the observation. However, the amplitude of the solar cycle is relatively small, about 0.2 W m^{-2} globally averaged (Lean 2005), and the change of observed global sea surface temperature response to solar variation is less than 0.1°C, there has always been a question that how this small variation could be amplified to produce significant responses in the earth system.

There are two major mechanisms proposed to explain the response of climate system to solar forcing. One is the “top-down” stratospheric ozone mechanism [Haigh, 1996; Balachandran et al., 1999; Shindell et al., 1999] which emphasizes the variation in stratospheric ozone in response to solar ultraviolet (UV) variability. The other is the “bottom-up” air-sea coupling mechanism [Meehl et al., 2003; Van Loon et al., 2007] which suggests that the increased net solar radiation over cloud-free regions in the subtropics translates into greater evaporation and moisture convergence. This strengthens the trades and cooler SSTs in eastern equatorial Pacific. We will use two state-of-the-art fully coupled earth system models, COSMOS (Community system Earth models) and CCSM4 (Community Climate System Model), to investigate the influence of the 11-year solar activity on the global climate system. The sensitivity of including 11-year solar forcing is examined. The preliminary results indicate that the atmosphere temperature may indeed response according to the additional solar forcing for both models. Also, the “bottom-up” air-sea coupling mechanism can be reproduced in the COSMOS model. We will further examine and quantify the possibly amplification resulting from the small solar variation in the future work.

1B3.1 ID:4914 11:00

Modeling North Pacific Decadal Variations and Their Teleconnection Patterns

Pei-Ning Feng , *Yu-Heng Tseng*
Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan
Contact: r98229014@ntu.edu.tw

Empirical orthogonal function (EOF) has been commonly used to identify the leading modes at different horizontal levels, which change phase at annual, interannual to quasi- decadal scale. From top to the surface, the leading EOF mode of 500 hPa is well-known as Pacific/North-American Pattern (PNA). For the SLP pattern, the first EOF mode is known as Aleutian Low (AL) in the Pacific Ocean, and North Atlantic Oscillation (NAO) in the North Atlantic region. At the ocean surface, the corresponding pattern in the Pacific Ocean is well-known for Pacific Decadal Oscillation (PDO) in the mid- latitude and the El Niño Southern Oscillation (ENSO) in the tropics. In the Atlantic basin, Atlantic Multidecadal Oscillation (AMO) is defined as the SST anomalies. AMO also shows the changing phase in time. Furthermore, the second modes of climate patterns SLP and SST also play an important role on modulating the climate variability because they were highly correlated with the change of the ecosystems. The second EOF modes include low frequency oscillations in decadal scales. In the Pacific Ocean, the second mode at 500hPa, SLP and SSH(or SST) are Western Pacific (WP), North Pacific Oscillation (NPO) and North Pacific Gyre Oscillation (NPGO) respectively. We will evaluate the existing climate variability and teleconnection patterns in the North Pacific using latest Atmosphere-Ocean General Circulation Model (AOGCM). This will help us to enhance our current understanding of the North Pacific Climate and improve the climate predictions. Using different model experiments, we are trying to identify the underlying physical mechanisms driving the climate variability and teleconnection. Finally, we anticipate to bridging the low-frequency climate variation to the global climate pattern.

3P707.2 ID:4915 15:30

Southern Hemisphere extra-tropical forcing on ENSO - Observation and Model Comparisons

Han-Ching Chen , *Yu-Heng Tseng*
(Presented by *Han-ching Chen*)
National Taiwan Univervity Atmospheric Sciences
Contact: r98229029@ntu.edu.tw

The mechanisms of ENSO and its patterns and impacts to climate are well-known from the literatures, however, the origin of ENSO still remains unknown. It has been confirmed that there are two types of ENSO; namely East Pacific ENSO (EP ENSO) and central pacific ENSO (CP ENSO). Both are driven by different driving mechanisms which require better understanding currently. We will discuss these driving mechanisms and how the ENSO is generated here. We first analyzed the observational data for both ENSO and their driven mechanisms. Further, we tried to construct the relationship between ENSO and Antarctic forcing. Several climate model simulations are performed to verify these driven mechanisms. Radon Transform (RT) will be used to determine the direction and phase speed of Arctic Circumpolar Wave (ACW) and Global ENSO Wave (GEW) to clarify the relationship among ACW, GEW, and ENSO. To distinguish the significance of CP ENSO and EP ENSO, we used combined regression EOF (CREOF). The EOF analysis for the whole Pacific Ocean and the tropics shows that ENSO is not only limited in the tropics but is a dominant pattern of the Pacific Ocean. The CP ENSO also strengthened and had a higher frequency after the climate regime shift in the 1970s. The analysis of ACW shows that the negative anomaly of zonal surface wind (ZSW) propagates eastward in the mid-latitude in the south hemisphere before the occurrence of EP ENSO. This is shown in both observation and ECHAM model, which indicates that ACW does impact EP ENSO and is driven by the ocean forcing.

4B4.1 ID:4916 INVITED/INVITÉ 10:30

From process models to numerical models; the tools that Dan employed to advance our understanding of shelf sea circulation

Andrew Willmott
Natioanl Oceanography Centre
Contact: ajwil@noc.ac.uk

Dan developed elegant process models to elucidate the role that topography, wind stress and bottom friction play on shelf sea circulation. At sub-inertial time scales, Dan’s research focussed on the role played by vorticity waves in the time dependent adjustment of shelf seas to wind and buoyancy driving. The impact of topography and bottom friction on shelf sea tidal dynamics was also elegantly illustrated by several novel process studies spearheaded by Dan.

What also stands out about Dan’s career is how effectively he used elegant process models to underpin our understanding of the results from numerical shelf, and ocean, circulation models, a skill that is in short supply today!

In my presentation I will review the key contributions that Dan has made in our understanding of shelf sea circulation, and for some selected problems I will bring the "story" up to date.

3C3.5 ID:4917 14:30

Ocean Climate Change in the Northwest Atlantic

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

Atmospheric and oceanic factors affecting ocean climate change in the Northwest Atlantic (NWA) are reviewed, drawing on recent modelling, observational and assessment studies. Particular attention is given to the important roles of the subpolar and subtropical gyres, the Atlantic Meridional Overturning Circulation (AMOC) and Arctic outflows in the NWA's present climatology, and of their variability in influencing the Atlantic Canadian shelf/slope region and its ecosystems. Probable or potential large-scale "tendencies" for anthropogenic climate changes in key oceanographic variables are suggested, and potential implications of these changes for the shelf/slope region are described. The need for coupled atmosphere-ocean climate models to resolve the dynamics of the NWA's western boundary currents (e.g. Labrador Current and Gulf Stream) and the natural modes of atmospheric variability (e.g. the North Atlantic Oscillation) is discussed. The importance of a coordinated broad-scale observational program of the North Atlantic's circulation to both regional and global climate change questions is noted, with reference to current and planned international programs.

2D0.4 ID:4918 16:45

Canadian Ice Service (CIS) Update of 30-Year Climatological Sea Ice Atlases (1981-2010)

Steve Mccourt , *Lionel Haché* , *Dan Fequet*
Canadian Ice Service (Environment Canada)
Contact: steve.mccourt@ec.gc.ca

The Canadian Ice Service (CIS), a division of the Meteorological Service of Canada (MSC), is a centre of expertise for ice related information for all of Canada and its surrounding waters. The CIS mandate is to collect and analyse data in order to report ice conditions in all regions of the country affected by the annual cycle of ice growth and decay. This data has been used to build a digital database of sea ice information going back to 1968. The data represents the primary dataset that is used in the generation of climate products and atlases (which the CIS has been publishing since 1980).

In keeping with World Meteorological Organization (WMO) standards, CIS has recently completed the update of their 30-year climatological ice atlas series for 3 areas of interest: "East Coast of Canada", "Great Lakes", and "Northern Canadian Waters". The 1981-2010 update builds upon the previous series of atlases that covered the period 1971-2000.

A number of methodologies and techniques have been employed to summarize the ice data into a meaningful and useful set of output statistics. Many of the techniques and algorithms from the previous atlas work were used and in some cases improved upon (e.g. areas of land-fast ice). In addition to the standard suite of products, a new product has been produced for inclusion into the atlases, "Median Concentration of Ice When Ice Is Present". Results and findings will also be presented as comparisons with the previous 30-year time period.

The atlas products represent an important tool to CIS operational staff, internal and external users and stakeholders, and they also serve as the primary datasets for the creation of products such as "Departure from Normal Ice Concentration".

2C0.5 ID:4919 15:00

A model sensitivity study of the space-time evolution of the sea ice distribution in the northwest Atlantic

Maud Guarracino [1], *Charles Hannah* [1], *Frederic Dupont* [2], *Fraser Davidson* [3]
[1] Bedford Institute of Oceanography, Fisheries and Oceans Canada
[2] Environment Canada
[3] Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada
Contact: Charles.Hannah@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 an analysis of the sensitivity of the sea ice distributions to the details of the ocean simulation. We consider the sensitivity to the use of spectral nudging to maintain the ocean state and to the values of the air-ice and ice-ocean drag coefficients. The focus is on the impact on the space-time evolution of the sea ice distributions in the northwest Atlantic.

2D2.3 ID:4920 16:30

Using sonic anemometers for design and testing of wind shields

Tilden Meyers , *John Kochendorfer* , *Ed Dumas* , *Mark Hall*
NOAA/ARL/ATDD
Contact: tilden.meyers@noaa.gov

The United States Climate Reference Network (USCRN) has a primary goal to provide long-term homogeneous observations of temperature and precipitation that can be coupled to long-term historical observations for the detection and attribution of present and future climate change. Accurate measurements of precipitation necessitate the use a continuous weighing gauge. For quality measurements of snowfall, rain gauges encased within a wind shield to maximize the "catch" of solid precipitation during windy conditions are necessary.

Major studies have been undertaken to evaluate the catch ratio of the more common and some alternative shield configurations All of these studies use the resultant total accumulation of some reference standard to evaluate the performance of various shield configurations. To fully understand the effectiveness of the various wind shield configurations, several wind shield studies were conducted to evaluate the airflow at and near the gauge orifice placed in several wind shield configurations. The mean and turbulent flow fields around each wind shield configuration were characterized with sonic anemometers which can rapidly measure the three dimensional flow vectors. In particular, the wind speed at the gauge was compared to a reference sonic anemometer located on a small mast some distance away from the fences.

Remarkably, the ranking of the wind shields by reduction in the mean wind speed at the gauge similar to the catch ratios published in major WMO studies, suggesting that the flow field measurements may

provide a useful tool for designing and quantifying catch ratios for existing and new wind shield configurations. The results also suggest that the low porosity double Alter, which is smaller in footprint than the DFIR or SDFIR, may generate the necessary flow field characteristics to provide catch ratios similar to the DFIR.

2B2.4 ID:4921 11:15

Data Services from the Meteorological Service of Canada

Shannon Allen , *Trisha Ralph-Coffey* , *Tara Sopoco*
Environment Canada
Contact: trisha.ralph-coffey@ec.gc.ca

The demand for National Climate Services has increased dramatically in recent years. As more specialized clients emerge, the need for a greater level of knowledge and information increases. To keep up with the demand and evolving clientele, a new team was established in the Meteorological Service of Canada in 2008 to improve and enhance the relevance, visibility and availability of historical climate data and services to the Canadian public. The National Climate and Information Archive website (http://climate.weatheroffice.gc.ca/) is one of the primary means by which Environment Canada provides access to historical climate data and related information. Many requests sent to National Climate Services are fulfilled by the climate and engineering products and services provided on the website. More specialized requests require customized services, which will be explored in this presentation. Updates to popular online products for the building and renewable energy sector such as the Canadian Weather Energy and Engineering Datasets (CWEEDS) and the solar radiation information in the Canadian Renewable Energy Resource CD-ROM (CERES) are planned for 2012. Work on the 1981 to 2010 Canadian Climate Normals is also currently underway. As well, beginning in 2011, Environment Canada's Climate Services and Hydrologic Applications and Services groups will join forces to explore and create products and services, building on the interrelationships between climate and water quantity data. This paper reviews what data resources are presently available online and highlights the products and services that are available by request.

2C3.4 ID:4922 14:45

Comparison of UV-B broadband Brewer measurements with irradiances from surface-based and satellite-based models

Jacqueline Binyamin [1], *John Davies* [2], *Bruce Mcarthur* [3]
[1] University of Winnipeg
[2] McMaster University
[3] Meteorological Service of Canada
Contact: j.binyamin@uwinnipeg.ca

UV-B irradiance can be estimated from surface meteorological data or from satellite measurements. This paper compares irradiance estimates from the McMaster University surface-based radiation model and the Canada Centre for Remote Sensing (CCRS) satellite model with Brewer spectrophotometer measurements for all sky conditions at six Canadian stations (Edmonton, Regina, Winnipeg, Montreal, Halifax and Toronto). The McMaster model is applied with both the discrete ordinate radiative transfer (DISORT) or the delta-Eddington algorithms to solve the radiative transfer equation. Both models estimates are compared with instantaneous Brewer measurements. Both perform similarly with mean bias errors within 6% of the mean measured irradiance for the measurement period and root mean squared errors between 25% and 30%.

2B2.1 ID:4923 10:30

Meteorological Service of Canada's Data Management Initiative

Tony Colavecchia
Environment Canada
Contact: tony.colavecchia@ec.gc.ca

Data is the foundation of science, products and services. Data management problems have a significant negative impact on results and resolving these problems has a direct improvement on results. Some common data management problems include: inconsistencies and duplication, evolving agendas, accelerating rate of change, sustainability of data management applications and data governance. The presentation will provide an overview of the Meteorological Service of Canada's data management initiative highlighting challenges, successes and next steps. The goals of the initiative are to ensure that data assets are effectively processed in real-time, are of known quality and effectively stored to facilitate easy discovery, access, use, expansion and exchange.

1C3.2 ID:4924 14:15

Spatiotemporally variable coastal upwelling circulation in northeastern South China Sea

Jianping Gan , *Jingjing Wang* , *Linlin Liang*
Hong Kong University of Science and Technology
Contact: magan@ust.hk

Coastal upwelling in the northeastern South China Sea (NSCS) is one of the strongest coastal upwelling sites along the entire coast of the China Seas. It upwells nutrient rich deep water to the sea surface and forms the important fishing ground in China Sea. The upwelling circulation maintains in the NSCS in most of southwesterly monsoon season and is very difficult to break down once it is spun up, even during periods with zero or opposite alongshore wind stress. The upwelling is governed by a complex dynamic system involving the interactions among the forcing of Southeast Asia summer monsoon, the dynamic constraint of uniquely widened shelf, setting-up/setting-down of upwelling pressure gradients by the frictional effect and by remote waves/inflows from the neighboring seas. This dynamic system is temporally and spatially variable and as a result, it causes an alternating spin-up/spin-down of upwelling circulation. Combined the comprehensive field investigations of both mapping and time series measurements with three-dimensional and multi-scale/multi-physics numerical circulation modeling studies, we identified characteristic variation and associated dynamics of the circulation as function of time over the shelf.

2C0.2 ID:4925 14:15

Evaluation of SST Analyses and Forecasts with the CONCEPTS Global Coupled Prediction System

Francois Roy [1], *Gregory Smith* [2], *Jean-Marc Bélanger* [2], *Bruce Brasnett* [1], *Harold Ritchie* [2], *Pierre Pellerin* [2], *Charles-Emmanuel Testut* [3], *Gilles Garric* [3]
[1] Centre Météorologique Canadien, Service Météorologique du Canada, Dorval, Québec, Canada
[2] Recherche en Prévision Numérique, Environment Canada
[3] Mercator-Océan, Toulouse, France
Contact: francois.roy@ec.gc.ca

We present results from the ¼ degree global ocean system being developed for CONCEPTS (Canadian Operational Network of Coupled Environmental PredicTion Systems), in collaboration with the French operational ocean forecasting centre Mercator-Océan. The surface ocean mixed layer plays an important role in the interactions with the atmosphere. As part of the development of a coupled atmosphere-ice-ocean forecasting system based on GEM-NEMO, we examine sea surface temperature (SST) results from yearly ocean simulations and 10 day forecasts initialized with the Mercator Assimilation System (SAM2). The diurnal cycle and its effect on the mixed layer depth and the SST are also studied using hourly forecast data from the Canadian atmospheric model GEM to force the NEMO ice-ocean model. Results are compared with SST analyses from the Canadian Meteorological Centre (CMC) and with AVHRR data. Forecast biases and RMS errors are examined under different model configurations where we assimilate different SST analyses (NCEP-RTG or CMC) in SAM2 and apply different atmospheric forcing methods; hourly or averaged radiative fluxes, different bulk formulas, coupled or uncoupled to the atmospheric model.

1P607.1 ID:4926 16:00

The Monitoring of Surface Ozone and PM2.5 Observations at the Canadian Meteorological Center.

Yulia Zaitseva , *Lorraine Veillette* , *Gilles Verner* , *Isabelle Provost* , *David Anselmo*
Environment Canada
Contact: yulia.zaitseva@ec.gc.ca

A new SQLite real-time database for air quality surface observations has been created at the Canadian Meteorological Center (CMC). This database includes observations from Canadian stations received directly from Canadian data providers and observations from US stations retrieved from the Environmental Protection Agency (EPA). Thus, an objective analysis system (OA), which is an essential step to initialize numerical models at regular time intervals, has access to a greater number of observations through this new database. Various flags, indicating the quality and validity of the observations, have been added to the database as well as processed quantities, such as observation minus first-guess values (O-P), observation minus analysis values (O-A), observation errors and first-guess errors.

A number of programs have been written in order to establish a monitoring system for the new database. Monitoring procedures include the examination of the O-P and O-A statistics for surface ozone and PM-2.5 on both an hourly and a day-to-day basis or in terms of monthly means. It is also possible to evaluate the quality of the data for all the stations as a group or the quality of the data for individual stations. This enables the detection of problems for a particular station, which can in-turn provide valuable feedback to the data provider.

This poster will describe the new database and the monitoring system in more detail, as well as provide samples of the various products that are available for monitoring on an internal EC website.

2C2.2 ID:4927 14:30

Addressing the challenge of measuring continental precipitation

Stewart Cober , *Paul Joe* , *David Hudak* , *Howard Barker* , *Faisal Boudala* , *Ismail Gultepe* , *George Isaac* , *Alexei Korolev* , *Norman Donaldson*

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

The accurate measurement of precipitation has application to several components of the global energy and water cycles including short and long term weather prediction, hydrology forecasting, climate diagnostics and modeling and oceanography amongst others. These applications require understanding of 1) the underlying physical processes which produce precipitation; 2) the physical processes that govern the interactions between precipitation in the atmosphere and the surface; 3) direct and remote sensing measurement techniques; and 4) assessment of the measurement uncertainty as well as the variability of the measurements both temporally and spatially. Significant unresolved challenges exist for each of these issues. For example, the formation of light shallow ice phase precipitation in the Arctic has been difficult to observe, and hence the process is not fully understood. Most surface precipitation measuring instruments cannot accurately measure light solid precipitation, hence the usefulness of much of the monitoring network for such conditions is debatable. In order to address these challenges, Environment Canada has formed multidisciplinary research teams who are undertaking long-term systematic approaches in the following areas: 1) the utilization of satellite-based remote sensing instruments (primarily radar) for the continental and global measurement of precipitation including light precipitation and precipitation in northern latitudes. The satellites used, or planned, include CloudSat, EarthCARE, the Global Precipitation Mission and a proposed Polar Precipitation Mission; 2) the development of improved methods for measuring precipitation at the surface including light and solid precipitation. Utilization of hot plate sensors, a spinning arm hot-wire sensor, the Precipitation Occurrence Sensing System and other vertical pointing radars, optical distrometers, present weather sensors, and others are being investigated; 3) the improved application of precipitation observations to numerical weather, climate and hydrological models, through improved measurement and physical process parameterization. An overview of the applications, challenges, potential solutions and plans will be presented.

1C3.4 ID:4928 14:45

Impacts of Canada Basin Freshwater Content on the Pacific Water Inflow Routes within the Arctic Ocean

Xianmin Hu , *Paul G. Myers*
Department of Earth and Atmospheric Sciences, University of Alberta
Contact: xianmin.hu@gmail.com

The Pacific inflow through the Bering Strait brings large amount of heat and freshwater into the Arctic Ocean every year. Subsequently, it plays a significant role in both dynamical and thermodynamical processes within the Arctic Ocean, e.g., the ice melting in the western Arctic and maintaining of the Arctic halocline. It is also one of the primary sources of freshwater in the Arctic Ocean. However, its pathway entering the arctic basins is not well studied so far. In our presentation, we will first estimate the mean Arctic Ocean freshwater budget from the numerical simulation using a coupled sea-ice and ocean high resolution pan-arctic model. Based on the control simulation, we will then investigate the two main routes of Pacific water transported into the interior basins using Lagrangian particle tracking. Instead of focusing on the impact of Pacific water inflow on the Arctic Ocean freshwater, in the last part, we will present its routes variation due to the loss of freshwater within the Canada Basin.

4C6.2 ID:4929 13:45

Wind Monitoring for Wind Energy in Ontario

Matthew Corkum [1], *Peter Taylor* [1], *Wayne Hocking* [2]
[1] Department of Earth and Space Science, York University
[2] Department of Physics, University of Western Ontario
Contact: corkumm@yorku.ca

The Ontario-Quebec VHF Windprofiler Radar Network includes 10 wind profilers in southern Ontario and Quebec. These units use frequencies in the range 40 to 55 MHz and cover a altitude range of about 150 meters up to 15 km altitude. Recent progress in data processing and quality control has made the data from these profilers more dependable and more accurate. Although the current Global Environmental Multiscale (GEM) 15 km regional and North American Mesoscale (NAM) 12 km models show significant errors in some cases, the wind profiler data are currently being tested for assimilation by Environment Canada. The lower height range data from these profilers can also provide useful data for wind energy resource assessment.

Recently, wind monitoring has begun offshore in Lake Ontario by Toronto Hydro with interest in a potential offshore wind farm east of Toronto. The platform monitoring station consists of a lidar as well as sensors at platform level. Data from this lidar platform shows how the Canadian Wind Energy Atlas does well as a first estimate of the wind resource while on site monitoring is needed for accurate wind energy estimates. With increasing amounts of wind power being fed into the grid, forecasting for wind power is becoming much more important. An assessment of the wind forecasting skill of the current models for this site, and what improvements are needed will be discussed.

3C1.4 ID:4930 14:15

Using Total Lightning Data in Severe Storm Prediction: Case Studies from the North

Chonglin Liu [1], *Stan Heckman* [2]
[1] Chief Architect & Director Engineering
[2] Senior Lightning Scientist
Contact: shumenik@earthnetworks.com

Intracloud (IC) lightning is better correlated to storm severity than cloud - to - ground (CG) lightning, providing early indicators of the development of severe thunderstorms that may produce damaging hail, high wind or tornados. The detection of total lightning flashes, especially IC flashes, enables improvements in the lead time of severe weather prediction and alerting. The WeatherBug Total Lightning Network™ (WTLN), created specifically for total lightning detection, can detect both IC and CG flashes efficiently. The high density of the lightning sensors in North America ensures high detection efficiency of both IC and CG flashes in the region.

The properties of lightning cells preceding numerous severe storms in various locations have been studied and certain predictive patterns in the lightning cells have been identified. The time evolution of the lightning flash rate and the IC/CG ratio of individual cells are used to identify severe thunderstorms with significant lead time before they occur. Studies have shown that early detections in the sudden rise of the rate of IC discharges and subsequent peak of total flash rate can serve as an indicator for severe storm conditions. Using WTLN lightning data, a real - time lightning cell tracking and the WeatherBug Dangerous Thunderstorm Alert program has been developed. The results of several storm studies using WTLN lightning data from North United States and Canada will be presented.

3P302.1 ID:4931 15:30

Regime shift temperature in the Red Sea

Perdana Prihartato [1], *Dionisyios Raitsos* [2], *Ibrahim Hoteit* [3]
[1] Red Sea Research Center, King Abdullah University of Science and Technology, Saudi Arabia
[2] Institute of Oceanography, Hellenic Center for Marine Research, Greece
[3] Red Sea Research Center, King Abdulllah University of Science and Technology, Saudi Arabia
Contact: perdana.karim@kaust.edu.sa

Satellite measurements of sea surface temperature from AVHRR sensors have been available since 1985 to present day providing exceptional coverage of the Red Sea. Analysis of these data suggests the presence of a global linear increasing trend of SST which seems to have affected the Red Sea temperature due to global warming as confirmed by Northern Hemisphere Temperature. AVHRR data also show a shift in the Red sea temperature, which might be considered as a regime shift. Here we conduct a Rodionov's regime shift analysis to confirm the sudden change ($r = 0.76$, $P < 0.05$) in SST with various climate indexes. The regime shift corresponded to 0.69oC change from the average and 20% higher in the summer. The satellite observations were further found to be highly correlated with air temperature in situ ($r = 0.96$, $P < 0.01$). This regime shift might lead to change in the biological system such as coral reef and fisheries production in the Red Sea.

2B0.2 ID:4932 10:45

Towards an integrated marine Arctic prediction system for METAREAs

Harold Ritchie [1], *Gregory Smith* [2], *Christiane Beaudoin* [2], *Mark Buehner* [2], *Serge Desjardins* [3], *Pierre Pellerin* [4], *Charles-Emmanuel Testut* [5], *Gilles Garric* [5]
(Presented by *C. Harold Ritchie*)
[1] Meteorological Research Division, EC, Dartmouth NS
[2] Meteorological Research Division, EC, Dorval QC
[3] Meteorological Service of Canada - Atlantic, EC, Dartmouth NS
[4] Meteorological Research Division. EC, Dorval QC
[5] Mercator-Océan, Toulouse, France
Contact: harold.ritchie@ec.gc.ca

In December 2007 Canada accepted official designation as the Issuing Service for meteorological Marine Safety Information (MSI) in the form of forecasts / warnings and ice bulletins for METAREAs XVII and XVIII as part of the Global Maritime Distress and Safety System (GMDSS). These areas are in the Arctic bordering on Canada. An important part of Environment Canada's involvement is the development of an integrated marine Arctic prediction system and satellite products in support of monitoring and warnings. The integrated marine Arctic prediction system will feed into a highly automated information dissemination system. In particular, our group is working on the development, validation and implementation of marine forecasts with lead times of 1 to 3 days using a regional high resolution coupled multi-component (atmosphere, land, snow, ice, ocean and wave) modelling and data assimilation system to predict near surface atmospheric conditions, sea ice (concentration, pressure, drift, ice edge), freezing spray, waves and ocean conditions (temperature and currents). The core of the system will be an Arctic extension of the highly successful Gulf of St. Lawrence coupled modelling system, with the GEM (Global Environmental Multi-scale) model as the atmospheric component coupled to the NEMO (Nucleus for European Modelling of the Ocean) ice-ocean model. An ice-ocean data assimilation system is being developed in collaboration with Mercator-Océan using their SAM2 system for ocean data assimilation together with the 3DVAR ice analysis system developed at EC. The METAREAs research and development is a cornerstone activity within the Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS). This talk will provide an overview of these activities, illustrate some results to date, and discuss plans for future operational systems.

1P301.1 ID:4933 16:00

Internal tide generation in the presence of background currents

Michael Dunphy , *Kevin Lamb*
University of Waterloo
Contact:

Internal waves in the ocean often propagate in an environment that includes background shear currents. Situations where this occurs includes short waves propagating through sheared currents induced by internal waves with much longer wavelengths, such as internal solitary waves propagating through an internal tide, and internal waves propagating through eddies or larger scale background currents such as the Kuroshio Current or the Gulf Stream. Here we consider internal tide generation by tidal flow over topography in the presence of a surface trapped background sheared current. A 2D non-hydrostatic model is used to carry out numerical simulations for a variety of background currents. Two stratifications are considered: linear and linear with a pycnocline. Analysis is done in terms of the traditional linear energy flux and the available potential and kinetic energy flux upstream and downstream of the ridge.

2B0.4 ID:4934 11:15

Assimilation of ASCAT data in an automated sea ice analysis system

Mark Buehner
Meteorological Research Division, Environment Canada
Contact: Mark.Buehner@ec.gc.ca

A three-dimensional variational data assimilation system has been developed at Environment Canada for producing high-resolution analyses of sea-ice conditions for the waters surrounding North America and Greenland. Until now only ice information from passive microwave sensors and the operational products of the Canadian Ice Service have been assimilated. An assessment of the impact on analysis quality of additionally assimilating ASCAT observations will be presented. A measure of the anisotropy of the backscatter is assimilated where the probability of sea ice being present is high. To reduce the creation of spurious ice over open-water areas, a retrieval of zero ice concentration is assimilated instead of the satellite measurements in areas with a high probability of being ice free. Quality control procedures applied to the data before assimilation are also described. The complementary nature of passive microwave and scatterometer observations for estimating sea-ice concentration will be highlighted.

2D4.2 ID:4935 16:30

Observations of circulation and tides in the Sable Gully

Blair Greenan , *Brian Petrie* , *Diana Cardoso*
Bedford Institute of Oceanography
Contact: blair.greenan@dfo-mpo.gc.ca

The Gully, the largest submarine canyon in eastern North America, was designated as a Marine Protected Area in May 2004. Located off Nova Scotia near Sable Island, the Gully contains a rich diversity of marine habitats and species, including deep-sea corals and the northern bottlenose whale.

The physical oceanography component of this multi-disciplinary field program consisted of two ship-based hydrographic surveys and the deployment of four current moorings for the period of April 2006 to August 2007. The annual mean flow from the current meter moorings indicates that a deep flow into the Gully is a persistent feature of the circulation. Evidence of a rim-depth eddy is also suggested from these results. Current meter measurements within the canyon have been compared to a nearby region on the continental slope and indicate that the low-frequency current variance (average 0-1500m) is similar in the two areas; however, the Gully has significantly greater diurnal (ratio Gully/Slope = 66), semi-diurnal (1.2) and high frequency (2.1) variance. The total variance in the current meter time series is 2.5 times larger in the Gully as compared to the slope region. Intensification with depth of the semi-diurnal and diurnal tides is observed along the axis of the Gully, along with the generation of a series of non-linear harmonics (MK3, M4, MK5, M6, MK7).

1P308.6 ID:4936 16:00

Physical, chemical and biological oceanographic variability in the Labrador Sea during 2000-2009

Igor Yashayaev , *Kumiko Azetsu-Scott* , *Blair Greenan* , *Glen Harrison* , *Erica Head* , *Ross Hendry* , *Bill Li* , *John Loder* , *Phil Yeats*
(Presented by *Blair Greenan*)
Bedford Institute of Oceanography
Contact: blair.greenan@dfo-mpo.gc.ca

Variability in the water mass properties and plankton in the Labrador Sea (LS) region during the decade 2000-2009 are described based on annual spring surveys along the WOCE AR7W line, remote sensing data, Argo floats and other information sources. The surveys are being carried out as part of Canada’s Atlantic Zone Off-Shelf Monitoring Program. The observed variability is interpreted in relation to longer-term and larger-scale ocean and atmospheric observations. Temperature and salinity over the upper 2000m have generally been increasing since 1995, with the exceptions of cooling associated with enhanced deep convection in 2008 and freshening in the upper 50m since 2002. Total inorganic carbon concentrations have increased over the past decade in the central LS with a corresponding decrease in pH of 0.03. Dissolved oxygen concentrations in the same water mass have shown a persistent downward trend, attributable to both reduced solubility caused by warming and increased biological consumption. Decadal trends in near-surface nutrients are indicative of a decreasing influence of arctic waters and an increasing influence of subtropical Atlantic waters. Phytoplankton and bacteria both have shown slight positive decadal trends in abundance in the eastern LS, negative trends on the Labrador Shelf, and little apparent change in the central LS. Trends in reproduction and abundance of the dominant zooplankton species, Calanus finmarchicus, have been linked to ocean temperature at the time spawning and to the timing of the phytoplankton bloom.

2C6.3 ID:4937 14:30

Why can't climate models capture the observed connection between seasonal snow cover and the Northern Annular Mode?

Karen Smith [1], *Paul Kushner* [1], *Judah Cohen* [2], *Christopher Fletcher* [3]
[1] University of Toronto
[2] Atmospheric and Environmental Research, Inc.
[3] University of Waterloo
Contact: ksmith@atmosp.physics.utoronto.ca

The suite of general circulation models (GCMs) in the Coupled Model Intercomparison Project (CMIP3) have been found not to reproduce the observed relationship between October Eurasian snow cover anomalies and the wintertime Northern Annular Mode (NAM). This apparent deficiency is reexamined here based on analysis of observational data and GCM simulations with prescribed snow forcing. Previous work has shown that in a comprehensive GCM in which an 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. The wave response and background climatological stationary wave must interfere constructively to achieve wave activity amplification into the stratosphere and the zonal mean stratosphere-troposphere NAM response. Using observational data, it is shown that constructive interference also occurs in the observed October Eurasian snow cover-NAM connection. This constructive interference peaks in December, corresponding to strong wave activity flux into the stratosphere two months after the snow cover anomalies in October. By contrast, the CMIP3 GCMs typically show a negative correlation between October Eurasian snow cover and December wave activity flux, which is related to destructive interference between the wave train associated with the snow and the background stationary wave. This work suggests that differences in the phasing of regionally forced waves can have a significant effect on stratospheric variability.

2C0.3 ID:4938 14:30

Spectral Nudging for Improving Global Coupled Atmosphere-Ocean Model Forecasts

Zhongjie He [1], *Hal Ritchie* [2], *Keith Thompson* [1], *Fred Dupont* [2], *Youyu Lu* [3]
[1] Dalhousie University
[2] Environment Canada
[3] Fisheries and Oceans Canada
Contact: keith.thompson@dal.ca

To improve the forecast ability of a coarse resolution global coupled atmosphere-ocean model, the 'spectral nudging' method is applied to assimilate the observed hydrographic climatology into the ocean model. The method significantly reduces model biases in the long-term mean distribution of temperature and salinity, which commonly exist in coarse-resolution ocean models. At the same time, the high frequency variance of the model state is not directly affected by the nudging and evolves prognostically. By reducing the long-term biases of sea surface temperature and salinity in the ocean model, the surface fluxes are expected to be improved significantly, hence improving coupled model forecasts. This research is being conducted in the framework of the GEM (Global Environmental Multi-scale) atmospheric model and the NEMO (Nucleus for European Modelling of the Ocean, from Mercator-Océan, France) ocean model, within the Global Ocean-Atmosphere Prediction and Predictability (GOAPP) network. It is an extension of spectral nudging research conducted by Dan Wright and GOAPP colleagues, with the objective of transferring GOAPP technology to the GEM-NEMO data assimilation and prediction system that is central to the Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS). We will present results showing the impact of spectral nudging in a coupling-ready version of NEMO when driven by forcing fields from atmospheric reanalyses, and preliminary results of the impact in a global coupled version of GEM-NEMO.

4B2.1 ID:4939 10:30

Quantification of uncertainty in high resolution temperature scenarios for North America

Guilong Li [1], *Xuebin Zhang* [2], *Francis Zwiers* [3], *Qiuzi Wen* [4]

[1] MSC-Ontario Region
[2] Climate Research Division, Environment Canada
[3] Pacific Climate Impacts Consortium
[4] York University
Contact: xuebin.zhang@ec.gc.ca

A framework for the construction of probabilistic projections of high resolution monthly temperature over North America using available outputs of opportunity from ensembles of multiple general circulation models (GCMs) and multiple regional climate models (RCMs) is proposed. In this approach, we first established a statistical relationship between RCM output and that from the respective driving GCM and then applied this relationship to downscale outputs from a larger number of GCM simulations. Those statistically downscaled projections were used to estimate empirical quantiles at high resolution. Uncertainty in the projected temperature was partitioned into five sources including difference in emission scenarios, differences in GCMs, internal variability simulated by GCMs, differences in RCMs, and statistical downscaling including internal variability at finer spatial scale. We found large spatial variability in projected future temperature changes, with increasingly larger changes towards the north in winter temperature and larger changes in the middle latitudes US in summer temperature. We also found that downscaling to small spatial scale contributes more to the uncertainty in the projected temperature changes than any other sources except that uncertainty due to GCMs becomes the most important for the summer temperature towards the end of the 21st century.

1C6.3 ID:4940 14:30

Diminished windstorm frequency in southwest British Columbia and a possible association with the Pacific Decadal Oscillation regime shift of 1976-77: Using atmospheric pressure as a proxy to support observed trends in extreme winds

Wolf Read
University of British Columbia, Department of Forest Sciences
Contact: wolfread@interchange.ubc.ca

During the 1962-1992 era that the U2A anemometer was in operation at Vancouver International Airport (CYVR), a distinct downward shift in the frequency and magnitude of windstorms (events with >13 m/s wind) occurred after 1975. This windstorm dearth appears to be bounded by the years 1976- 1989, with the strongest depression in frequency from 1983-1989. This pattern also appears at Abbotsford (CYXX) and Victoria (CYYJ). The Pacific Decadal Oscillation regime shift of 1976-77 is proposed as a possible explanation for the reduced windstorm frequency in parts of southwest BC from 1976-1989. However, there remains the possibility that changes in site characteristics or observational methodology may explain the long-term inflection in high-wind frequency. Barometric pressure observations are not affected by the same factors that influence wind measurement. To further lend support to the observed trends in wind, a pressure-gradient triangle using sea-level pressure for CYVR, CYYJ and CYXX from 1953-2008 is used as a proxy to observed wind speeds. Geostrophic wind potential is calculated from the hourly data, and the trend in extreme events—in this case discrete storms with gradients of >0.45 kPa/100 km (where $G \geq 33$ m/s) is examined vis-à-vis the wind record at the three stations. The pressure- triangle calculations show a pattern similar to the measured wind. The signal is perhaps not as strong, and the downward trend in extreme events does not appear to be as sharply associated with the 1976-77 regime change. Also, after a period of relatively low extreme-gradient frequencies in the mid- 1980s, there does not seem to be much of a return to the higher frequencies that are evident before 1976-77.

4D6.2 ID:4941 15:45

A model of ice throw trajectories from wind turbines

Peter Taylor [1], *Sumita Biswas* [2], *Jim Salmon* [3]
[1] York University and Zephyr North Canada
[2] York University
[3] Zephyr North Canada
Contact: pat@yorku.ca

An ice throw model is developed to calculate the trajectory of an ice fragment of known mass and size in three dimensions. It also provides the impact location on the ground. Initially standard values for mass and size of ice fragment, hub height, blade length, drag coefficient, wind speed are specified. The greatest distance an ice fragment of 1 kg (rotor speed 14.5 rpm) could travel was roughly 200 m. Sensitivity tests were then done to see the impact of varying the mass of the ice fragment, the position of the ice fragment on the blade, the drag coefficient, rotor speed and wind speed. It was found that the throwing distance is strongly dependent on these parameters. Finally an initial risk map for ice throw hazard has been generated. To make the model more reliable needs more information from field sites on ice fragment size and mass distributions. The results from the model could then be combined with the meteorological data for the turbine location to better predict the nature, frequency and occurrence of ice throw hazards.

1C4.3 ID:4942 14:30

Rigorous inter-comparison of three hydrodynamic models for Lakes Erie and Ontario

Frederic Dupont [1], *Padala Chittibabu* [2], *Anning Huang* [2], *Ram Yerubandi* [2], *Vincent Fortin* [1], *Youyu Lu* [3]
[1] MRD, Environment Canada
[2] CCWI, Environment Canada
[3] BIO, Department of Fisheries and Oceans
Contact: frederic.dupont@ec.gc.ca

As part of an ongoing project of coupling a three dimensional lake model with the atmospheric GEM model and a river router, a rigorous intercomparison (same forcing, same grid, same initial conditions, same bulk formulae) of three hydrodynamic models, namely, Princeton Ocean Model (POM), Canadian version of Diecast (CANDIE), and Nucleus for European Modelling of the Ocean (NEMO) version 3.2 has been conducted for Lakes Erie and Ontario over 2005-2008 summers. During this period buoys measuring surface meteorological forcing, profile of temperarature and ADCPs were deployed in the lakes. All the models provided major characteristics of the flow and thermal structure of the lake, while NEMO had additional skills in representing the velocity fields. All models however had problems representing the sharp thermocline which isolates the bottom waters from the surface layer in a couple of meters. Further runs with NEMO over the full Great Lake system and covering the entire period of 2004-2009 provide a good opportunity to validate the model in terms of ice cover and lake levels.

3B1.4 ID:4943 11:15

An Evaluation of the GEM-REG Model Predictions for Hurricane Igor

Damian Braet
Defence Weather Services, Meteorological Service of Canada
Contact: damian.braet@ec.gc.ca

Hurricane Igor impacted eastern Newfoundland with heavy rain and strong winds late Monday September 20, 2010 into the afternoon of Tuesday, September 21. The hurricane moved northeastward and interacted with a stationary front to its north, undergoing extra-tropical transition as it intensified. The areas of highest rainfall and wind directly impacted the Newfoundland's eastern peninsulas, causing extensive damage. Even after completing extra-tropical transition northeast of the province, Igor continued to pummel the entire eastern half of Newfoundland with extremely high winds that continued over most areas well into the evening. The purpose of this presentation is to evaluate the performance of the GEM Regional model, in terms of Igor's track and intensity, compared to the actual event.

4C5.2 ID:4944 14:00

Physico-chemical factors affecting microalgal bloom dynamics in a coastal lagoon

Arielle Kobryn [1], *Diana Varela* [2]
[1] Dept. of Biology, University of Victoria
[2] Dept. of Biology & SEOS, University of Victoria
Contact: arielljk@uvic.ca

Coastal eutrophication is a global phenomenon that results in marked increases in the intensity and frequency of microalgal blooms. As the consequences of eutrophication become more apparent, it is critical to understand the environmental variables that control bloom dynamics of benign and harmful phytoplankton species. Our research characterizes microalgal bloom dynamics in a shallow, tidally-influenced water body (Esquimalt lagoon, B.C.) and addresses the conditions that enable the development and subsistence of these blooms. The succession of microalgal blooms in Esquimalt lagoon begins in early spring and continues until late fall. In 2010 the most substantial bloom occurred in April. This bloom was dominated by chain-forming diatoms and reached an average chlorophyll concentration of about 30 µg L-1. In September, the dinoflagellate Akashiwo sanguinea was dominant in the phytoplankton assemblage, and the average chlorophyll concentration was 20 µg L-1. During the occurrence of these two blooms, there were substantial differences in air and water temperature, tidal cycles, and precipitation/runoff; variation in environmental conditions is a continual process that intrinsically affects the succession of algal blooms in the spring, summer and fall. Aside from temporal differences in environmental variables, there are spatial differences within Esquimalt lagoon that could also affect bloom dynamics; these include proximity to ocean and freshwater inputs, as well as water depth and thus influence of the sediments. Differences in spatial and temporal conditions within the lagoon are leading us to investigate the interaction of physical properties of the water with one of the most fundamental factors controlling microalgal blooms: nutrient supply. In particular, we will explore how the stability of the water column, tidal cycles, and the contribution of freshwater versus ocean water affect nutrient concentrations, stoichiometry, and uptake by microalgae, to yield the blooming patterns that we observe.

4C3.1 ID:4945 13:30

Transport of a quasigeostrophic circumpolar current

David Straub [1], *Louis-Philippe Nadeau* [2]
[1] McGill
[2] NYU-Courant
Contact: david.straub@mcgill.ca

Numerical simulations are used to test various ideas relating to what sets the transport of the Antarctic Circumpolar Current in an idealized setting. `Chanel theories' link the eastward transport through Drake Passage to the wind stress, averaged over the path of the current, but do not provide an a priori estimate of the transport since the current's path is an unknown. 'Basin theories' relate the transport to the Sverdrup flux into the Drake Passage latitude band, but only take into account the wind stress curl, and not the wind stress itself. Both explain aspects of the transport observed in our eddy-resolving quasigeostrophic simulations, and an attempt is made to present a conceptual model that borrows ideas from both basin and channel theories and fits the model results over a wider range of parameters than do basin or channel theories individually. Limitations of the quasi-geostrophic equations for addressing this problem are also briefly discussed.

1P205.1 ID:4946 16:00

Modeling dry deposition and resuspension of aerosols in atmospheric dispersion models

Jian Feng
Meteorological Service of Canada, Environment Canada
Contact: jian.feng@ec.gc.ca

Dry deposition and resuspension are two opposite processes for atmospheric aerosols. In this study, we first developed a new dry deposition scheme for use in atmospheric dispersion models. Secondly we reviewed the current existing methods for resuspension modeling, and implemented two parameterizations of resuspension rate into our dispersion models.

To deposit on the ground surface, an airborne aerosol particle needs to pass through an aerodynamic resistance layer and a quasi-laminar sublayer just adjacent to the surface. Traditionally it is believed that the main mechanisms through which a particle overcomes the resistance from the quasi-laminar sublayer are Brownian diffusion, interception, inertial impaction and gravitational settling. In this study, we developed a size-resolved dry deposition model, which includes a new proposed dry deposition mechanism, the burst effect of eddy turbulence. The effect on dry deposition is parameterized with the roughness Reynolds number.

Currently there are three methods for predicting resuspension of atmospheric aerosols, namely the resuspension factor method, the resuspension rate method, and the mass-load method. In this study we focused on the second one, the resuspension rate method. This method is appropriate for short-term (a few minutes to days) prediction of resuspension of freshly deposited particles. When the parameterization of resuspension rate is incorporated into dispersion models, it can be used to predict the air concentration of resuspended materials over the resuspension and downwind regions.

1P602.1 ID:4947 16:00

Networking for a Network of Networks

Gary Beaney , *Alex Zucconi*
Meteorological Service of Canada
Contact: Gary.Beaney@ec.gc.ca

The Meteorological Service of Canada (MSC) has always been a leader in meeting the hydrometeorological monitoring needs of Canadians on a national scale. With the advent of relatively low cost monitoring equipment of reasonable quality, in conjunction with the rapid development of easily obtainable and far reaching methods of communication, varying levels of government, private

industries and private citizens have taken it upon themselves to establish their own, more regionally based monitoring systems to meet their own specific monitoring needs. For the benefit of Canadians, the MSC seeks to adapt to this rapidly evolving new monitoring reality by championing an effort to coordinate weather, water and climate monitoring in Canada.

Network of Networks is the concept of formally linking weather, water and climate monitoring information from both government and non-government sources to provide a comprehensive inventory and source of hydrometeorological information for Canada.

Although the MSC will always provide the core of high quality, reliable observations Canadians require, only through partnership will the MSC and other data providers be able to meet the constantly emerging and evolving demands for weather, water and climate information from Canadians. The identification and coordination of various monitoring efforts across Canada will help achieve this goal as well as enable other data users easier access to the wealth of hydrometeorological information currently available within Canada.

The poster will present a graphical representation of both current EC monitoring capacity, as well as known non-MSC weather, water and climate monitoring within Canada. It will also provide non-MSC data providers the opportunity to interactively identify where their networks reside and view how their current or proposed monitoring capacity could contribute to a coordinated Network of Networks.

1B3.3 ID:4948 11:30

Contribution of the autumn Tibetan Plateau snow cover to seasonal prediction of North American winter temperature

Hai Lin , *Zhiwei Wu*
Meteorological Research Division, Environment Canada
Contact: hai.lin@ec.gc.ca

Predicting surface air temperature (Ts) is a major task of North American (NA) winter seasonal prediction. It has been recognized that variations of the NA winter Ts can be associated with El Niño−Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). This study presents observed evidence that variability in snow cover over the Tibetan Plateau (TP) and its adjacent areas in prior autumn (September−November) is significantly correlated with the first principal component (PC1) of the NA winter Ts which features a meridional seesaw pattern over the NA continent. The autumn TP snow cover anomaly can persist into the following winter through a positive feedback between snow cover and the atmosphere. A positive TP snow cover anomaly may induce a negative sea level pressure and geopotential height anomaly over the eastern North Pacific, a positive geopotential height anomaly over Canada, and a negative anomaly over southeast US, a structure very similar to the positive phase of the Pacific-North American (PNA) pattern. This usually favors the occurrence of a warm-North-cold-South winter over the NA continent. When a negative snow cover anomaly occurs, the situation tends to be opposite. Since the autumn TP snow cover shows a weak correlation with ENSO, it provides a new predictability source for NA winter Ts.

Based on the above results, an empirical model is constructed to predict PC1 by a combination of autumn TP snow cover and other sea surface temperature anomalies related to ENSO and the NAO. Hindcasts and real forecasts are performed for the 1972−2003 and 2004−2009 periods, respectively. Both show a promising prediction skill. As far as PC1 is concerned, the empirical model hindcast performs better than the ensemble mean of four dynamical models from the Canadian Meteorological Center. Particularly, the real forecast of the empirical model exhibits a better performance in predicting the extreme phases of PC1, i.e., the extremely warm winter over Canada in 2009/2010,

should the model include the autumn TP snow cover impacts. Since all these predictors can be readily monitored in real time, this empirical model provides a real time forecast tool for NA winter climate.

4C5.3 ID:4949 14:15

Understanding the upstream coastal spread of Aquatic Invasive Species (AIS) in Maritime Canada

David Brickman
DFO
Contact: David.Brickman@dfo-mpo.gc.ca

Dispersal of AIS is achieved through anthropogenic vectors and/or natural water exchange between embayments. Species of concern in Maritime Canada, such as colonial or solitary tunicates, Codium and green crab, can disperse via larval drift or as post larvae/juveniles rafting on small debris. Understanding movement of species between estuaries is therefore an essential aspect of managing AIS introduction and spread.

The Nova Scotia and Gulf of Maine (GoM) coastal currents, although known to fluctuate in magnitude and direction, typically proceed in a northeast-to-southwest direction following the coastline. However, numerous invasions (e.g. green crab) have been observed to proceed against the mean coastal current.

To address this problem, the NEMO circulation model, set up on a domain that includes the shelf seas of Maritime Canada, was forced by atmospheric variability for a typical year as derived from the US National Center for Environmental Prediction (NCEP normal year forcing). Flow fields from this “climatological” simulation will be used to determine the probability and associated timescales of upstream coastal dispersion of AIS for various propagule-release scenarios.

4C6.3 ID:4950 14:00

Improvement to mesoscale wind climate modelling in cold climate steep mountains

Philippe Pham [1], *Robert Benoit* [1], *Christian Masson* [1], *Jean-Paul Pinard* [2]
[1] École de Technologie Supérieure, Montreal, QC
[2] 703 Wheeler street, Whitehorse, YT
Contact: philippe.pham.1@ens.etsmtl.ca

This research describes the improvement of the mesoscale wind climate modelling methodology implemented in the AnemoScope software used for mapping the wind energy potential. It was shown in a previous study (Pinard et al, 2009, Atmos. Ocean) that AnemoScope did not successfully reproduce the wind climate in Yukon. It had been argued that the thermal stratification and stability of the Yukon during cold climate were not fully represented and caused some of the boundary-layer wind predictions to be too large.

The attempted method to fix these issues is to implement an additional classification variable to the already existing ones (direction, magnitude and shear of the geostrophic wind) to also take into consideration the thermal stratification. In this case, the Froude number, along with other minor modifications, were added to the classification scheme applied on the NCEP/NCAR Reanalysis used to initialize the model. This new classification method calculates the Froude number for each data, and then puts them in their respective Froude number bin to create additional climate states for the model to use. It was noticed that the frequency histogram of the Froude number of the Reanalysis data, although showing some occurrences of highly stable events, was quite different from the histogram deduced from the measured Radiosonde data of a neighbouring weather station. Therefore, correction factors derived from the long-term Radiosondes database were introduced to modify the Reanalysis Froude curve to make it resemble the Radiosonde ones. This means the frequency of lower Froude numbers (stable states) were increased and the frequency of higher Froude numbers (quasi-neutral states) were decreased for the Reanalysis.

By inserting these new and modified climate states, we have been able to represent the different thermal stratification conditions in cold mountainous climate and improve some of the wind predictions and the corresponding downscale climate in the Whitehorse valley. Generalization of these finding to the mesoscale wind climate mapping of other cold weather mountainous targets is attempted.

2C4.2 ID:4951 14:15

Modeling estuarine circulation and sediment transport induced by subglacial freshwater discharges in glacial fjords

Julio Salcedo-Castro [1], *Daniel Bourgault* [2]
[1] Memorial University of Newfoundland
[2] Université du Québec à Rimouski
Contact: j.salcedo@mun.ca

Glacial fjords are estuarine systems where freshwater comes mostly from subsurface freshwater discharges located at mid-depth (englacial) or underneath the glacier (subglacial). The estuarine circulation induced by this type of forcing is examined by running a number of simplified experiments covering a range of buoyancy and jet dominated conditions, with a non-hydrostatic two-dimensional model. The results show a jet issuing from the tunnel which rises as a vertical wall plume and then, after impinging the surface, it spreads horizontally to give place to an estuarine circulation, with a thin upper layer moving seaward and a deep lower layer moving toward the glacier. Velocity of the surface layer is related to Fr number according to a negative power function, implying that the estuarine circulation is mostly driven by the buoyancy flux from the source (subglacial jet issuing at the bottom). Similarly, plume dilution is also higher at lower Fr number, showing a higher entrainment caused by faster velocities at the surface layer. A second group of experiments was run to describe the effect of sediments on glacial fjords circulation. Cohesive sediment was chosen to tackle this problem as this fraction is the most important in glacial fjords. Experiments with and without flocculation were run in order to estimate differences on sediment transport.

1B4.5 ID:4952 12:00

A Rogue Wave Event at Middle Cove Beach, Newfoundland

Devon Telford
EC/ MSC / Atlantic
Contact: devon.telford@ec.gc.ca

On the afternoon of Sunday, August 31, 2008, large shoaling waves that were described by observers as ‘rogue’ occurred at Middle Cove Beach, Newfoundland, washing over beach-goers and effectively pulling four of them out into the cove where they where rescued by bystanders. Although the raw wave data obtained for this study shows that rogue waves were present in the wave field, it was the

length of the swell period that was the significant contributor to the event. NWP guidance leading up to the event resolved it well. Through a study of the synoptic meteorological scenario, wave forecasting techniques, local topography and bathymetry, an operational nomogram was developed to give proposed warning thresholds for similar events based on significant swell height, period and tide height. With the knowledge of this synoptic event and with the use of the nomogram perhaps similar situations may be accurately forecasted and appropriate action may be taken to inform the public.

3B4.4 ID:4953 11:45

Spectral nudging and deep Labrador Sea convection events

Frederic Dupont [1], *Zeliang Wang* [2], *Daniel Wright* [2], *Youyu Lu* [2]
[1] MRD, Environment Canada
[2] BIO, Department of Fisheries and Oceans
Contact: frederic.dupont@ec.gc.ca

Late Dan Wright made significant contributions to the improvement of the spectral nudging technique in ocean model applications, in collaboration with many colleagues. The essence of the method is to keep the mean state (and optionally the seasonal cycle) consistent with observed climatology, while allowing the variability at other frequencies to freely evolve according to forcing and dynamics. In eddy-permitting modelling of the North Atlantic, this method enables the Gulf Stream to separate from the shelf at the correct location, and allows the meso-scale eddies to be generated by instability. Dan spent considerable effort improving the method by using weaker constraints and designing better spatial filters, etc. However, the method has a problem for decadal and longer simulations because it overly constrains the low frequency variability, for example, variations of the deep convection events in the Labrador Sea. In order to overcome this problem, the method of using the time-mean nudging was proposed by Lu et al. (2007) for a coarse-resolution modelling application. In this study, the same idea is applied in an eddy-permitting model based on the Nucleus for European Modelling of the Ocean (NEMO) model. The improvements on the simulation of deep convection in the Labrador Sea and implications for climate ocean models will be discussed.

4C3.6 ID:4954 14:45

Quantifying the uncertainty of the climate change signal and the inter-model spread in the context of an ensemble of opportunity

Martin Leduc , *Laprise René*
Université du Québec à Montréal
Contact: leduc@sca.uqam.ca

From the climate modelling point of view, an ensemble of opportunity, consists of a group of simulations generated using several climate models developed by different research centres around the world. This kind of ensemble is useful to measure the impact of the structural uncertainties onto the spread of the model's climate-change projections. In a large sample such as the CMIP3 multi-model dataset generated in the context of the Fourth Assessment Report of the IPCC, models were analysed according to their availability rather than in a specific, systematic or random manner. Moreover, research groups provide an arbitrary number of simulations generated from one or several versions of their model. The choice of simulations to be used in the multi-model ensemble and how to combine them to obtain climate-change projections is somewhat arbitrary and vary across authors. In the present work, we evaluate the uncertainty arising from both the choice of the models and the members onto the ensemble statistics, namely the climate-change signal and inter-model spread. The statistical

uncertainties are also studied as function of the ensemble size, using different subsets of models extracted from the whole CMIP3 ensemble.

3P701.1 ID:4955 15:30

Soil climate implications for carbon flux modelling

Diana Verseghy
Environment Canada, Climate Research Division
Contact: diana.verseghy@ec.gc.ca

Peat soils are large reservoirs of organic carbon, as are many permafrost soils. It is well known that carbon fluxes from such soils are strongly dependent on soil temperature and water content, and for the purpose of modelling studies it is therefore important to ensure that the soil climate is being reliably modelled. Proper characterization of the hydraulic and thermal properties of both mineral and organic soils, a realistic treatment of the seasonal snow cover, and adequate spatial resolution in the discretization of the soil are key in this regard.

This paper outlines work that has been done in testing the Canadian Land Surface Scheme "CLASS" over eastern Canada, a region that is characterized by large variations in vegetation and soil types. (This initiative builds upon the snow simulation work that was done in this area as a contribution to the Canadian IPY research programme.) CLASS was driven offline using seven years of forcing data downscaled from ERA-40 reanalyses using the Canadian Regional Climate Model, at a grid resolution of 25 km. Detailed soil and vegetation data were aggregated from a 1-km resolution dataset compiled for the Mackenzie GEWEX Study. Various sensitivity tests dealing with the soil climate and snow cover algorithms, and investigations of soil configuration strategies, will be presented.

3P701.2 ID:4956 15:30

Modelling Carbon Assimilation for an Ontario Boreal Spruce Plantation -- Canadian Carbon Program (CCP)

Phillip Reynolds , *Gordon Brand* , *Allan Cameron*
Natural Resources Canada, CFS
Contact: preynold@nrcan.gc.ca

The ability of forests to sequester Carbon varies. Young vigorously growing plantations may have greater sequestration potential than mature stands. Annual Carbon assimilation was estimated for a mixed 20-year-old black and white spruce plantation near Timmins, Ontario. Carbon assimilation was measured for each species (black and white spruce, balsam fir, white birch and trembling aspen) using a LiCor 6400 Photosynthesis System to develop light saturation curves for nine PAR values each at six air temperatures. 3-D surface models relating net assimilation to temperature and PAR were developed for each species. These models were coupled with daily and seasonal air temperature and PAR to generate daily, monthly, and seasonal rates of Carbon assimilation. Data were then combined with leaf area index measurements to estimate daily, monthly, or seasonal Carbon assimilation per hectare. Maximum assimilation rates were highest for the hardwoods, approaching 3 times that of conifers. Rates were higher for aspen than birch. For conifers, rates were highest for black spruce, followed by white spruce, and fir. Species differences were also evident for optimal temperatures of Carbon assimilation. Maximal assimilation occurred between 10 and 15o C for fir, between 15 and 20o C for black spruce, and between 20 and 25o C for white spruce. Assimilation peaked at 30o C and 35o C for birch and aspen respectively. Net assimilation at the lowest temperature (10o C) was

seasonally dependent: higher in the fall when soils were warmer than in spring following snowmelt. These data suggest greater potential for conifer assimilation in the off seasons (spring/early summer and autumn). By contrast, greater hardwood assimilation occurs during the summer months. Increased assimilation is expected as annual growing seasons lengthen due to global warming. By occupying different niches for Carbon assimilation, species are able to reduce competition and coexist in the same stand.

3C5.1 ID:4957 13:30

Modelling Carbon Assimilation for Boreal Jack Pine Plantations -- Ontario Long-term Soil Productivity (LTSP) -- Canadian Carbon Program (CCP)

Phillip Reynolds , *Gordon Brand*
Natural Resources Canada, CFS
Contact: preynold@nrcan.gc.ca

The LTSP study was established in Ontario in 1993 to examine the effects of harvesting and other site preparation techniques on long-term productivity (i.e., yield, biomass, Carbon sequestration) of pine or spruce plantations. Annual Carbon assimilation was estimated for a 10-year-old jack pine plantation near Thessalon, Ontario. Small plot treatments consisted of tree-length (TL) harvested with standard disc-trenching, full-tree (FT) harvested with disc-trenching, FT harvested with blading, and FT harvested with blading and soil compaction. Half of each plot was herbicide released annually. Carbon assimilation was measured for each treatment using a LiCor 6400 Photosynthesis System to develop light saturation curves for nine PAR values each at six air temperatures. 3-D surface models relating net assimilation to temperature and PAR were developed for each treatment. These models were coupled with daily and seasonal air temperature and PAR to generate daily, monthly, and seasonal rates of Carbon assimilation. Data were then combined with leaf area index measurements to estimate daily, monthly, or seasonal Carbon assimilation per hectare. Maximum Carbon assimilation occurred between 20 and 25o C. Net assimilation at the lowest temperature (10o C) was seasonally dependent: higher in the fall when soils were warmer than in spring following snowmelt. These data suggest greater potential for assimilation in the off seasons (spring/early summer and autumn). Site preparation, rather than harvest nutrient removals or herbicides, appears to have had the greatest impact on Carbon assimilation. Assimilation rates were highest for plots site prepared with disc-trenching, and lowest for bladed and/or compacted plots. Increased assimilation is expected as annual growing seasons lengthen due to global warming. Additionally, assimilation can be increased by disc-trenching and avoidance of blading or heavy compaction. Without optimization of site preparation methods, then Carbon assimilation rates can be expected to differ widely on either a stand or landscape scale.

1P504.1 ID:4958 16:00

Assimilation of AVHRR data in an automated sea ice analysis system

Andrea Scott [1], *Mark Buehner* [1], *Tom Carrieres* [2], *Alain Caya* [1]
[1] Meteorological Research Division, Environment Canada
[2] Marine and Ice Services Division, Environment Canada
Contact: Mark.Buehner@ec.gc.ca

A three-dimensional variational data assimilation system has been developed at Environment Canada for producing high-resolution analyses of sea-ice conditions for the waters surrounding North America and Greenland. Until now only ice information from passive microwave sensors and the operational products of the Canadian Ice Service have been assimilated. An assessment of the impact on analysis quality of additionally assimilating AVHRR observations will be presented. Four visible/infrared channels are assimilated directly using a simple observation operator based on precomputed tie-points for sea ice, open water and cloud. To reduce the creation of spurious ice over open-water areas, a retrieval of zero ice concentration is assimilated instead of the satellite measurements in areas with a high probability of being ice free. Quality control procedures applied to the data before assimilation are also described. The complementary nature of passive microwave and visible/infrared observations for estimating sea-ice concentration will be highlighted.

4C6.4 ID:4959 14:15

Wind farm power forecasting using numerical weather prediction model

Joseph Ismael Touani Tchanko [1], *Wei Yu* [2], *Yves Gagnon* [3], *Christian Masson* [1]
[1] École de technologie supérieure (ÉTS), Montréal (Qc), Canada
[2] Environment Canada, Dorval (Qc), Canada
[3] Université de Moncton, Moncton (NB), Canada
Contact: josephisma2@yahoo.fr

With the rapid growth of the installed wind power capacity, the electricity utilities are facing challenges in integrating this energy source to the electric grid due to the intermittent nature of the wind. The objective of the study is to develop a physical model for wind power production prediction using Numerical Weather Prediction (NWP) model outputs. Establishing an accurate wind farm power curve, which translates the predicted meteorological variables for a given wind farm to its power production, represents one of the important step towards the successful prediction of wind power production. In this study, several experiments have been conducted to identify an accurate way to model the wind farm power curve using historical wind farm power production and wind speed measurements. Comparing the Bin Method and Artificial Neural Networks (ANN), results show that ANN perform better, mainly due to the fact that they can easily add more variables with a limited quantity of data. Also, the influence of several parameters has been tested using ANN. These parameters include wind speed, wind direction, air density, turbulence intensity and wind shear. Two additional methods for the wind farm power curve modeling have been examined. The first method consists in modeling the wind farm power curve by comparing the wind speed at a reference wind mast to the total power output; while the second method consists in modeling the wind farm power curve by comparing the average wind speed at the hub height of each wind turbine to the total power output. The wind farm power curves developed are then used to predict power output using GEM-LAM 2.5 km predicted meteorological variables as inputs. The methods were applied to an operating wind farm in Eastern Canada. Detailed results will be presented at the conference.

2B1.5 ID:4961 11:45

Observation and prediction of Wind Gust During the 2010 Winter Olympics in Vancouver : Model comparisons

Faisal Boudala , *Jocelyn Mailhot* , *George Isaac* , *Stewart Cober* , *Janti Reid* , *Ivan Heckman*
Environment Canada
Contact: faisal.boudala@ec.gc.ca

Extreme weather events associated with a sudden brief increase in wind speed, which is traditionally referred to as wind gust (WG), can have significant impacts on the natural environment by causing considerable damage to forests and man made structures. These events also affect daily human activities including air and ground transportations, particularly when they are associated severe weather events. Typically in Canada, WG is calculated by examining the 5-second averaged peak wind during the previous 10 or 15 min, but the method of calculating WG can vary depending on the intended application. Predicting and modeling such a brief change in wind speed is extremely challenging, and the current Numerical Weather Prediction (NWP) models cannot directly predict this quantity. Rather WG estimated are diagnosed based on the model predicted mean wind. During the 2010 winter Olympics in Vancouver, two algorithms for predicting WG were assessed. The first is based on the assumption that the WG is produced as a result of the deflection of air parcels by turbulent eddies from higher up in the boundary layer down to the surface. This method takes into consideration the turbulence kinetic energy (TKE) and the stability of the boundary layer (SBL). The algorithm was implemented in the 1- and 2.5-km resolution Limited Area Model (LAM) version of the Canadian Global and Environmental Multiscale (GEM) model. The second method assumes a similar process, but instead of assessing the TKE and the SBL, it uses an empirical equation that depends on the boundary layer thickness and predicted mean wind speeds in the BL. This algorithm was implemented in both the LAM and regional version of GEM (GEM-Reg), the latter of which has 15 km spatial resolution. In this presentation the following topics will be discussed: a) detailed descriptions of the two algorithms; b) determination of WG based on observations at several sites, c) comparison of predicted and observed WG values.

4C4.3 ID:4962 14:15

Coastal Ocean Colour: Spatial-Temporal Variability and Detection Challenges in the Strait of Georgia, British Columbia, Canada

Eduardo Loos [1], *Maycira Costa* [1], *Nicholas Komick* [2]
[1] University of Victoria, Remote Sensing and Spectroradiometry Laboratory - Dept. Geography - V8W 3R4
[2] Fisheries and Oceans Canada, Pacific Biological Station - V9T 6N7
Contact: Eduardo.Loos@dfo-mpo.gc.ca

Only recently have we started to characterize the spatial-temporal optical properties of the surface waters of the Strait of Georgia. Based on spring/summer data, we have found that light scattering is generally much higher in surface plume waters closer to the Fraser River ($b(650nm) \approx 16.0m^{-1}$) compared with deeper/northern waters of the Strait ($b(650nm) < 7.0m^{-1}$). Light absorption in short wavelengths is also lower in deeper/northern waters ($a(411nm) < 1m^{-1}$) compared with plume waters ($a(411nm) > 1.5m^{-1}$). These differences are mainly a result of high concentrations of inorganic particles and dissolved organic matter in the plume and phytoplankton in deeper/northern waters.

The understanding of these differences has been important for the development of chlorophyll algorithms based on ocean colour imagery, such as imagery provided by the MODIS sensor. In situ spectra allowed for the development of a semi-analytical algorithm based on the GSM1 model, modified according to the characteristics of the dominant phytoplankton group and the absorption by chromophoric dissolved organic matter (CDOM). This algorithm yielded a statistical relationship with $R^2=0.68$ and linear slope close to one.

The merging of these findings with satellite imagery has proven to be problematic mostly because of difficulties to correct imagery for atmospheric effects. Using a modified version of “Management Unit of the North Sea Mathematical Models”, which allows for changes in aerosol type and optical thickness of the atmosphere based on SWIR and NIR data from the imagery, we obtained $R^2=0.72$ for estimates of imagery-derived chlorophyll in waters outside of the Fraser River influence. These are encouraging results but limited spatially and temporally.

We are evaluating imagery provided by MERIS, SeaWiFS, and data from the VENUS FerryBox. Ultimately, we intend to produce chlorophyll maps and associate them with the timing of initiation, duration, amplitude, and spatial distribution of phytoplankton blooms for their incorporation into fisheries management of the Strait of Georgia.

2D1.3 ID:4963 16:45

Communicating Weather with External Clients

David Jones
Meteorological Service of Canada
Contact: davidb.jones@ec.gc.ca

Whether it's the general public, crown corporations, major infrastructure providers, emergency planners, or key clients in other levels or departments of government, everyone occasionally struggles to make sense of the forecast. Making a decision based upon the daily forecast or the seasonal outlook requires meta-data that rarely accompanies these predictions. This presentation outlines some essential information clients need to make the best weather-related decisions.

4D5.2 ID:4965 16:00

Characteristics of diel vertical migration: bio-acoustic time-series from the VENUS network

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

Variability in the diel vertical migration of euphausiids in Saanich Inlet, British Columbia, is quantified using two years of echosounder data collected by the VENUS coastal network. The continuous and high-resolution nature of our observations enable examination of daily, seasonal and even interannual modulation of diel vertical migration in acoustic backscatter. Migration timing variability relative to sunrise and sunset is observed on seasonal and short-term (~ 36-d and ~ 14-d) periods. Spectral analysis reveals delayed evening ascent coinciding with early morning descent during periods of low chlorophyll a in winter, while early ascent coinciding with delayed descent during elevated chlorophyll a in short-term periods. Maximizing feeding time at the surface during high chlorophyll a suggests that fitness increases from feeding on phytoplankton is likely the ultimate driver of diel migration, supporting the hunger-satiation hypothesis. In order to maximize feeding efficiency while minimizing predation risk from visual predators, euphausiids appear to adapt their migration timing based on availability of phytoplankton.

3P706.3 ID:4966 15:30

Effect of the receiving environment on transport, fate and bio-uptake of contaminants from two submarine municipal outfalls.

Pamela Dinn [1], *Sophia Johannessen* [2], *Robie Macdonald* [2]

[1] University of Victoria and Department of Fisheries and Oceans
[2] Fisheries and Oceans Canada
Contact: pdinn@uvic.ca

The fate and bioavailability of persistent contaminants entering the marine environment via wastewater outfalls depends on the affinity to particles and on the physical and biogeochemical processes in the receiving environment. Here we evaluate the effect of the receiving environment on the dispersal of particle-reactive contaminants discharged into coastal water via two municipal wastewater outfalls by comparing a high energy, low sedimentation environment near Victoria, BC, Canada, to a low energy, high sedimentation environment near Vancouver, BC, Canada. Polybrominated diphenyl ethers (PBDEs) are bioaccumulative, particle-reactive contaminants whose main route of entry into the environment is wastewater, treated or untreated. They are found in highest concentrations close to point sources and therefore provide a proxy for other particle-reactive contaminants discharged with wastewater. In this study we use surface mixing rates and sedimentation rates, determined with 210Pb, as a basis for modeling the depositional history of PBDEs near the two outfalls. We compare: 1) the flux of PBDEs deposited into local sediment, 2) the rate at which PBDEs are buried by overlying sediment, 3) the proportions of PBDEs captured by sediment at the two contrasting sites. We then determine how the flux and sediment concentrations of these contaminants are reflected in PBDE burdens in benthic invertebrate communities at these locations, and whether or not metabolism or debromination are important removal processes.

1B1.4 ID:4967 12:00

Observation of Precipitation and Precipitation Type During the 2010 Winter Olympics in Vancouver and Its Impact on Visibility

Faisal Boudala [1], *George Isaac* [1], *Roy Rasmussen* [2], *Paul Joe* [1], *Stewart Cober* [1], *Ivan Heckman* [1]
[1] Environment Canada
[2] NCAR
Contact: faisal.boudala@ec.gc.ca

Precipitation plays a significant role in our planet by modulating the hydrological cycle and also by affecting daily human activities including air and ground transportation. For example, during winter snow storms precipitation can reduce visibility and also contributes to other severe weather phenomena such as blowing snow. Thus, accurate determination and prediction of precipitation, particularly over a complex terrain is very important. In principle precipitation can be measured using a weighting gauge which is as simple as an open container on the ground that can collect falling rain drops, snow and hail particles etc.. However, it is usually more complex, because of many factors such as wind effects; accuracy and the representativeness of the measurements in spatial and time scales. There are other kinds of instruments that can measure precipitation such as distrometers, hot plates, and scattering probes. Some of these instruments also suffer from wind effects and also need calibrations using weighing gauges. Considerable efforts have been made towards measuring precipitation and visibility using several of the instruments mentioned above during the 2010 winter Olympics in Vancouver and over the Whistler Mountain in British Colombia, Canada. This presentation will include the following: a) Several snowfall rate measuring instruments such as a Parsivel distrometer, Yankee HotPlate, Viasala FD12P, and Pluvio deployed over the Whistler mountain will be compared under various atmospheric conditions b) Precipitation type and visibility measured using the FD12P and Parsivel will be compared and the effect of precipitation type on visibility will be discussed.

2C5.2 ID:4968 14:30

Dissolved oxygen sensitivity to environmental changes in the Estuary and Gulf of St. Lawrence

Paul Nicot [1], *Yvonnick Le Clainche* [1], *Michel Starr* [2], *Joël Chassé* [3], *Diane Lavoie* [2]

[1] ISMER, Université du Québec à Rimouski, (Québec) Canada
[2] Institut Maurice Lamontagne, Pêches et Océans Canada, (Québec) Canada
[3] Gulf Fisheries Centre, Fisheries and Oceans Canada, (New Brunswick) Canada
Contact: paul.nicot@uqar.qc.ca

The presence of a permanent hypoxic zone in the Gulf of St. Lawrence deep waters, particularly in the Lower Estuary, has been an established fact since several years now. To evaluate the contribution of biological processes on oxygen consumption into the water column, we use a 3D coupled physical-biogeochemical model whose domain covers the Estuary (from Quebec City) and Gulf of St. Lawrence as well as the eastern Scotian Shelf. The physical model aptly reproduces the main physical oceanographic features of the Gulf of St. Lawrence and was intensively validated against field data from Atlantic Zone Monitoring Program (AZMP). A chemical model of marine oxygen cycle was included in a 8 compartments NPZD-type biological model. Spatial distribution and seasonal evolution of dissolved oxygen and nitrate concentrations are well represented in comparison with AZMP observations, giving confidence in the coupled model ability to reproduce biogeochemical dynamics of the system. Based on a reference simulation for year 2000, we performed two sensitivity analysis experiments by changing environmental conditions: (1) a reduction of freshwater flow from the St. Lawrence River; (2) an increase of nutrient inputs from river waters. These environmental changes, coherent with global climate warming and the ongoing increase in the supply of nitrogen from fluvial section, affect plankton dynamic and organic matter distribution in the Laurentian system. But how do they contribute to reduce oxygen concentration in deep waters of the Estuary and Gulf of St. Lawrence?

1B3.5 ID:4969 12:00

Interactive Lakes in the Canadian Regional Climate Model, version 5: the Role of Lakes in the Regional Climate of North America

Andrey Martynov , *Laxmi Sushama* , *René Laprise*
Université du Québec à Montréal
Contact: Andrey.Martynov@uqam.ca

Interactive Lakes were recently introduced into the Canadian Regional Climate Model, version 5 (CRCM5), aiming at better simulation of regional climate, particularly for lake-rich regions, such as the Canadian Shield and the Laurentian Great Lakes region. The lake coupling for both resolved and subgrid lakes was realised, using two different 1D lake models. Multi-annual simulations over the North- American continent using CRCM5 with interactive lakes are presented and compared with a simulation performed with the standard CRCM5 version, using prescribed lake water temperature and with a “no-lakes” simulation, with all internal waters removed and substituted by adjacent land.

2B6.4 ID:4970 11:30

The Madden-Julian Oscillation: A 100-year reconstruction and a discussion of predictability based on a stochastically forced damped oscillator model

Eric Oliver , *Keith Thompson*

Department of Oceanography, Dalhousie University
Contact: eric.oliver@dal.ca

The bivariate index developed by Wheeler and Hendon [Monthly Weather Review, 2004] has become the most widely accepted characterization of the Madden-Julian Oscillation. As this index relies on satellite-based observations it is not defined over the pre-satellite era. We use long records of sea level pressure from the 20th Century Reanalysis Project [Compo et al., QJRMS, 2011] to perform a reconstruction of the Wheeler and Hendon index back to 1905. The reconstructed index is validated by demonstrating that its temporal and spectral properties are consistent with the Wheeler and Hendon index over the common period (1979-2008). We also show that the low-frequency variability of the reconstructed index is consistent with independent observations. Finally, a stochastically forced, linear, damped oscillator model is used to explore the predictability properties of the Madden-Julian Oscillation.

3B4.2 ID:4971 INVITED/INVITÉ 11:00

Integrating Observational, Theoretical and Numerical Modelling Approaches in Deep Ocean Studies: An Overview with Emphasis on the Contributions of Daniel G. Wright

Youyu Lu
Bedford Institute of Oceanography
Contact: Youyu.Lu@dfo-mpo.gc.ca

This review focuses on the contributions of Daniel G. Wright and his collaborators to our understanding of the mean state and variability of the open ocean. Several examples will be presented to illustrate an integrated approach based on observational analyses, simple theoretical studies, and fully non linear, three-dimensional baroclinic numerical models. The examples will be drawn from contributions in the following areas: the dynamics of baroclinic instability; the interaction of bottom topography and stratification; the mean state and variability of the Labrador Current, North Atlantic Current and meridional overturning circulation in the North Atlantic; dynamics of the ocean mixed layer; bio-physical interactions; and development of eddy-permitting and eddy-resolving models for data assimilation, hindcast and forecast of the ocean.

3P701.4 ID:4972 15:30

Effects of Forestry Operations on Soil Respiration (CO2 Eflux) by Intensively Managed Boreal Jack Pine Plantations -- Ontario Long-term Soil Productivity (LTSP) Study -- Canadian Carbon Program (CCP)

Phillip Reynolds , *Gordon Brand*
Natural Resources Canada, CFS
Contact: preynold@nrcan.gc.ca

The Ontario Long-Term Soil Productivity (LTSP) Study was established in 1993 to examine the effects of harvesting and other site preparation techniques on long-term productivity (i.e, yield, biomass, Carbon sequestration) of either jack pine or black spruce plantations. This study reports on one of six replicated 10-year old jack pine plantations located within north-central Ontario. Small plot treatments consisted of tree-length (TL) harvested with standard disc-trenching (DT), full-tree (FT) harvested with disc-trenching (DT), FT harvested with blading (B), and FT harvested with blading (B) and soil compaction (C). Half of each plot was herbicide (H) released annually and the other half maintained as non-herbicided (NH). The overall hypothesis of the LTSP study is that soil compaction

or nutrient removals seriously impact future stand productivity, and presumably Carbon sequestration. To assess differences, soil respiration was measured monthly July through September 2009 and again May through October 2010 in all treatments at the Wells plantation and in an adjoining unharvested mature jack pine stand using a Li-Cor 6400 System. Soil respiration peaked in July/August declining thereafter. Data suggest no treatment differences between any of the four plantation treatments at any of the measurement times, but large differences between soil respiration rates for these treatments versus rates for the adjoining unharvested forest. For August 2010, mean values for the four herbicide (H) maintained treatments were 3.98 (FT/B), 4.43 (FT/B/C), 3.62 (FT/DT), and 4.79 (TL/DT) umol.m-2.s-1 CO2 compared with 8.05 umol.m-2.s-1 CO2 for the unharvested forest. Similar values were observed in August 2010 for the non-herbicide (NH) sub-plots: 3.36, 5.74, 4.42, and 3.95 umol.m-2.s-1 CO2, respectively, compared with 8.05 umol.m-2.s-1 CO2 for the unharvested forest. These results suggest the biggest differences in soil respiration rates are due to harvesting and not site preparation techniques. This finding is opposite measured Carbon assimilation rates where site preparation (B & C) has adversely impacted assimilation rates, and where avoidance of B & C is recommended. These preliminary results further suggest that Carbon assimilation is more sensitive to site preparation (B & C) than soil respiration. Soil respiration appears to be primarily affected by harvesting alone.

1C3.5 ID:4973 15:00

High-resolution basin-scale ocean modelling and analysis

Youyu Lu [1], *Ji Lei* [1], *Zeliang Wang* [1], *Shannon Nudds* [1], *Yuhua Lin* [2], *Zhihua Zhang* [3], *Frederic Dupont* [4], *Tsuyoshi Wakamatsu* [5]
[1] Bedford Institute of Oceanography
[2] Dalhousie University
[3] State Ocean Administration China
[4] Environment Canada
[5] Institute of Ocean Sciences
Contact: Youyu.Lu@dfo-mpo.gc.ca

High-resolution simulations of the North Atlantic, Arctic and North Pacific are carried out based on the Nucleus for European Modelling of the Ocean (NEMO). Validation with observational data shows that increased realism in key regions is achieved by increased model resolution. The presentation focuses on analysis of circulation and eddy variability in the Northwest Atlantic and influence of the deep ocean on the Scotian Shelf.

2C1.3 ID:4974 14:45

Wind forecasts using a 'micro' grid

Sarah Dyck , *Wei Yu* , *André Plante* , *Natacha Bernier* , *Evangelia Ioannidou*
Environment Canada
Contact:

Over the past few years Environment Canada, in collaboration with Hydro-Quebec, has developed, run, and evaluated SPEO (Système de Prévision Eolienne), a High-resolution Wind Energy Forecasting System. SPEO makes use of GEM-LAM and it is configured to run over a 2.5km grid. In an extension of this project, research is being done to investigate smaller 'micro' grid domains, centered over individual wind power plants. The primary goal of this project is to determine if these low cost and computationally efficient systems can provide a reliable high-resolution wind power forecasts.

Wind power forecasts rely primarily on wind, and to a lesser extent on temperature and humidity. Preliminary results from our experiments show that on average the micro grid can reproduce the wind forecasts produced using a larger domain without a significant change in the skill. With proper forcing of cloud information the surface temperature forecasts can also be reproduced with a micro grid. These results are quite promising. Further tests are required to evaluate the applicability of micro grids to other weather related needs and phenomena.

1B2.4 ID:4975 11:45

The Canadian AMDAR Program – An Updated Strategy for the Decade 2011-2020

Gilles Fournier
Environment Canada
Contact: gilles.fournier@ec.gc.ca

The Aircraft Meteorological Data Relay (AMDAR) program is one of a number of essential sources of upper-air (UA) data globally. Data from the AMDAR program are critical input for numerical weather forecasting, climate and air quality models, and are useful in the development of regional and short range weather forecasts. Additional sources of upper air data include the global radiosonde network, satellites, ground-based weather radars, and wind profilers. With continuing advances in weather modeling and computer capabilities, comes a growing demand for high resolution UA observations. Automated meteorological observations from commercial aircraft are an excellent cost effective means of supplementing in-situ UA observations obtained by conventional systems such as radiosondes.

Global cooperation on AMDAR is facilitated by the World Meteorological Organization’s (WMO) AMDAR Panel; which was established in 1998 by a number of WMO Members, including Canada, operating or intending to operate national or regional AMDAR programs. Globally, approximately 230,000 sets of AMDAR observations are disseminated daily on the Global Telecommunications System (GTS) involving over 2,300 AMDAR-capable aircraft from various airlines. The potential for significant AMDAR expansion exists in terms of spatial-temporal coverage and the types of parameters observed.

In Canada, the development of a national AMDAR Program began in 2000; however enrollment of airlines has remained limited due to significant technical difficulties. Lessons learned over the previous decade (2000-2010) have been used to update the 2011-2020 strategy for the sustainability and further expansion of the Canadian AMDAR Program. Results from the updated strategy will be presented in the context of the Meteorological Service of Canada's network planning and design activities, and the international AMDAR developmental efforts.

2C6.1 ID:4976 14:00

Simulation of the Northern Hemisphere "Cold-Low" Event Climatology Using a Coupled Climate Model

Steven Lambert
Canadian Centre for Climate Modelling and Analysis, Environment Canada
Contact: steve.lambert@ec.gc.ca

The "observed" Northern Hemisphere 500 mb cut-off low event climatology is extracted from 30 years of NCEP/DOE reanalyses. The corresponding event climatology is extracted from a "present-day" simulation by the Canadian Coupled Climate Model. The monthly means and standard deviations of the observed and simulated climatologies are compared and contrasted with special emphasis on the early summer "cold-low" season on the west coast.

3C3.1 ID:4977 13:30

Modelling the response of primary production to changes in freshwater runoff in the Estuary and Gulf of St. Lawrence

Diane Lavoie [1], *Michel Starr* [1], *Joël Chassé* [2]
[1] Fisheries and Oceans Canada, Maurice-Lamontagne Institute, P.O. Box 1000, Mont-Joli, QC, G5H 3Z4, Ca
[2] Fisheries and Oceans Canada, Gulf Fisheries Centre, 343 University Avenue, Moncton, NB, E1C 5K4 , Ca
Contact: diane.lavoie@dfo-mpo.gc.ca

The Estuary and Gulf of St. Lawrence form a complex system where circulation is driven by freshwater runoff, wind and tidal mixing. Its bathymetry is characterised by deep channels that run from the continental shelf to over 1000 kilometers inland. Tidally-induced upwelling and mixing of nutrient-rich water at the head of the Laurentian Channel in conjunction with an important freshwater outflow from the St. Lawrence and Saguenay rivers maintain a high concentration of nutrients at the surface of the Lower Estuary during most of the year. The influence of this “nutrient pump” can also be felt downstream in other parts of the Gulf of St. Lawrence. An hypoxic and acid zone is also found in the bottom layer at the head of the Laurentian Channel. Although rivers represent a direct source of nutrients for the surface layer, they also affect the nutrient pump through their control on upwelling and mixing at the channel head and on the intensity of the estuarine circulation. In this talk we will present results of an investigation of the effects of changes in freshwater fluxes (from hydropower development and climate) on (1) the input of nutrients to the surface layer of the St. Lawrence system, both directly and through its effect on vertical mixing, (2) the phytoplankton biomass and spatial distribution, and (3) the hypoxic and acid zone at the bottom of the Lower St. Lawrence Estuary. To achieve this, we are using a coupled 3D ice-ocean-biogeochemical(NPZD-O-pH) model forced with a hydrological model to simulate pre-dams river input, and with climatological runoffs calculated over the period following dam construction.

1C2.5 ID:4979 15:00

Radio-Frequencies Used by National Meteorological and Hydrological Services (NMHS)– An Overview of Current and Future Threats and Opportunities

Gilles Fournier
Environment Canada
Contact: gilles.fournier@ec.gc.ca

Radio-frequencies represent scarce and key resources used by National Meteorological and Hydrological Services (NMHS) to measure and collect the observational data upon which analyses and predictions, including warnings, are based or processed; and to disseminate this information to governments, policy makers, disaster management organizations, commercial interests and the general public. The utmost importance of radio-frequencies for all Earth Observation activities is to be stressed, in particular space-borne sensing of the Earth’s surface and atmosphere which plays an essential and increasingly important role in operational and research meteorology, and in the scientific

understanding, monitoring and prediction of climate change and its impacts.

Usage of the radio spectrum is already heavily congested, leading to a growing number of difficult situations. In particular, obligations to share spectrum with an increasing number of services and the consequential coexistence conditions require extreme care. Facing current and expected threats and lobbies representing huge economical interests (e.g. mobile operators, automotive industry, aviation industry), the meteorological community and the World Meteorological Organization (WMO) cannot afford to be absent from the debates to defend their interests and must actively contribute to ensure their positions are voiced, argued and supported. Such representation efforts are and will increasingly be time and cost consuming; however this should be balanced with the potentially huge consequences associated with the loss of, or interference with, any frequency bands used for meteorology (e.g. by satellites, radars, radiosondes).

This presentation will provide a brief summary of the current and future radio-frequency threats and opportunities to the NMHSs.

2D1.4 ID:4980 17:00

Alerting Canadians of significant weather events with the help of the Common Alerting Protocol (CAP)

Joanne St-Coeur
MSC - Environment Canada
Contact: joanne.st-coeur@ec.gc.ca

For years the traditional weather warning bulletins have been a fixture in the daily lives of Canadians. Technological advancement (science, communication protocols, etc) is opening opportunities on how we can alert Canadians, by moving beyond the traditional warning bulletin format.

Recognizing this situation, the Meteorological Service of Canada, will bring changes to its warning program over the years to come. New tools, along with new data management systems, are needed in order to bring these changes along.

One of the first changes the Meteorological Service of Canada will introduce is the ability to issue weather warnings in Common Alerting Protocol (CAP) format.

CAP is an agreed upon international standard for exchanging public warning information and emergency messages between alerting technologies. CAP allows a message to be consistently disseminated simultaneously over many warning systems to many applications and end users. CAP is an XML based standard which creates an environment that is extremely flexible to both the needs of alert issuers and last mile distributors alike.

4D0.4 ID:4981 16:15

Is the climate response to carbon emissions path dependent?

Kirsten Zickfeld [1], *Nathan Gillett* [2], *Vivek Arora* [3]
[1] Simon Fraser University
[2] Nathan.Gillett@ec.gc.ca
[3] vivek.arora@ec.gc.ca
Contact: kirsten_zickfeld@sfu.ca

Recent studies with coupled climate-carbon cycle models suggest that global mean temperature change is proportional to cumulative CO2 emissions, independently of the timing of those emissions. Here we examine the simulated response of a range of global and regional climate variables to the same cumulative CO2 emissions released along different pathways using a complex Earth system model. We find that for a plausible range of future emissions scenarios the response of most surface climate variables is largely independent of the emissions pathway once emissions cease. By contrast, variables with longer response timescales, such ocean heat content and thermosteric sea level rise, exhibit stronger path-dependence. As expected, prior to the cessation of emissions, climate variables are path-dependent, and in particular peak responses of variables such as CO2 concentration, surface ocean pH and sea ice cover are found to be dependent on the emissions pathway, particularly for overshoot scenarios. We conclude that the cumulative emissions framework is well suited for global mean temperature and precipitation, but is less consistent with other climate variables whose response is less constant after cessation of CO2 emissions. Also, we advise caution in applying this framework to emission scenarios with net removal of CO2 from the atmosphere, as such scenarios may lead to overshoot of maximal climate targets.

1P201.2 ID:4982 16:00

Observations of aerosol effects on the microphysics and radiative properties of Arctic liquid-phase clouds

Michael Earle [1], *Peter Liu* [1], *Walter Strapp* [1], *Alla Zelenyuk* [2], *Dan Imre* [3], *Greg Mcfarquhar* [4], *Nicole Shantz* [1], *Richard Leaitch* [5]
[1] Cloud Physics and Severe Weather Research Section, Environment Canada
[2] Chemical and Materials Sciences Division, Pacific Northwest National Laboratory
[3] Imre Consulting
[4] Department of Atmospheric Sciences, University of Illinois
[5] Climate Research Division, Environment Canada
Contact: Michael.Earle@ec.gc.ca

Aircraft measurements obtained during the Indirect and Semi-Direct Aerosol Campaign (ISDAC) in April 2008 are used to investigate the effects of aerosol on the microphysics and radiative properties of Arctic clouds, with the objective of improving understanding of aerosol indirect effects. The analysis is focussed on liquid-phase clouds in two separate regimes with respect to cloud and aerosol properties: single-layer stratocumulus with below-cloud aerosol particle concentrations (N_a) less than 300 cm^{-3} (clean cases); and inhomogeneous layered cloud with $N_a > 500$ cm^{-3} below-cloud during a biomass burning episode (polluted cases). Characterization of the aerosol below cloud base showed that particles in clean cases were composed primarily of organics, with size distributions shifted to slightly smaller sizes relative to those in polluted cases, which were composed mainly of biomass burning components. Based on a series of vertical profiles through cloud from six project flights, the average droplet number concentration (N_d) for polluted cases (304 ± 81 cm^{-3}) was larger than that for clean cases (136 ± 31 cm^{-3}), with average droplet effective radii (*Re*) of 5.7 ± 1.2 µm and 5.4 ± 0.7 µm, respectively. The similarity of *Re* values for polluted and clean cases is attributed to larger cloud liquid water paths (*LWP*) in the former, which are correlated with higher *Re*. Positive correlations were observed between *Re* and the cloud optical depth (τ) for both polluted and clean cases, for which τ ranged from 1.2   7.0 and 0.7   44.4, respectively. Similarly, positive correlations were observed between cloud albedo (*A*) and *Re* for both cases. Adiabatic parcel model simulations demonstrated that differences in droplet activation between the two aerosol-cloud regimes may also influence *Re*. These differences are explained largely by variations in N_a, the aerosol particle size distribution, and the vertical (updraft) velocity.

4C6.6 ID:4983 14:45

Site Specific Canadian Lightning Climatology: Application for Wind Turbine Lightning Protection

Mark W. Shephard , *Robert J. Morris* , *William Burrows* , *Leslie Welsh*
(Presented by *Mark Shephard*)
Environment Canada
Contact: mark.w.shephard@gmail.com

The CSA Wind Turbine Generator Systems – Lightning Protection standard has provisions to specify lightning protection measures based on the risk of a lightning strike on the wind turbine, which is in turn is based in part on the mean annual lightning flash density of the location. Thus, the numerical value of the site-specific climatological lightning flash density will have a direct impact economically in determining the lightning protection measures required, and for safety and protection of property in the event of lightning strikes.

In this research we have utilized 10-years of high resolution (~0.5 km) lightning data from the Canadian Lightning Detection Network (CLDN) data operated at Environment Canada that covers most of Canada. Ten years of observations has been used to publish the regional patterns, but in general is not a sufficiently long period to accurately represent the long term climatology at high resolution. This is because a few large thunderstorms can result in local random variations in lightning frequency that does not persist from year-to-year. At the same time, the high resolution data does show definite, persistent patterns in many other areas that reflect real, local variations in lightning occurrence. We will present the following procedure used to provide a representative long-term lightning climatology: (i) Generated annual 1-km lightning flash densities from 10-years of CLD data (1999-2008); (ii) Performed Getis-Ord spatial clustering analysis over 100x100km regions across Canada to obtain regional optimal averaging lengths used to smooth the randomness and at the same time retain significant smaller scale lighting patterns (e.g. mountain tops); (iii) Generated a 1-km site-specific lightning flash density climatology by applying the averaging lengths to the 1-km, 10-year mean annual lightning flash density values; (iv) Used the lightning climatology as input to generate wind turbine lightning protection levels specified in the CSA standard.

3C1.3 ID:4984 14:00

Gene-expression programming — a way to improve precipitation forecasts in mountainous W. Canada

Atoossa Bakhshaii [1], *Douglas Mccollar* [2], *Roland Stull* [1]
[1] UBC
[2] BChydro
Contact: abakhsha@eos.ubc.ca

Finding averages and probabilities from an ensemble of NWP outputs is an exercise in function fitting. Most function-fitting approaches assume a functional form (such as a polynomial or neural network) is chosen a-priori by the user. The corresponding regression or error-minimization algorithms are used only to find the parameters or weights in those functions. Gene expression programming (GEP) assumes that neither the functional form nor the weights/parameters are known. Instead, it uses a computational version of natural selection to test a wide variety of functional forms and weights until it finds a relatively good one. To do this, it first creates a somewhat random population of different candidate functions and weights, and then it evaluates each candidate against the "training set" of data to find which ones give the best verification scores. The best ones are retained, and some new formulations and weights are created as mutations of the old ones. This new generation of candidate functions is again tested against the training data set, and the natural selection process is invoked again. After many generations, the surviving functions and weights are ones that fit the training set quite well. The winner of this evolutionary competition is then verified against an independent "testing set" of data. This winner is a generic type of ensemble average called a deterministic ensemble forecast (DEF).

Comparing the verification scores of GEP DEF versus a traditional (equally weighted) ensemble-average DEF, the GEP DEFs were found to be better for about half of the mountain weather stations tested, while ensemble-average DEFs were better for the remaining stations.

1P306.6 ID:4985 16:00

Coloured Dissolved Organic Matter in the Strait of Georgia: Seasonality and relationships with freshwater discharge

Cynthia Wright , *Sophia Johannessen* , *Robie Macdonald*
Fisheries and Oceans Canada
Contact: Cynthia.Wright@dfo-mpo.gc.ca

Coloured (Chromophoric) dissolved organic matter (CDOM) absorbs ultraviolet and visible radiation and influences the degree to which radiation penetrates the water column. CDOM also undergoes photochemical oxidation, which releases carbon dioxide and nutrients. CDOM is supplied to the oceans by in situ algal production and by rivers, which vary seasonally with changes in the watersheds. The Strait of Georgia receives freshwater input from both rainfed and snowmelt-dominated rivers.

River water was collected from six Vancouver Island rivers, and two on the lower Mainland. Samples were also collected along a transect across the Fraser River plume and in vertical profile at two stations, one in the southern and the other in the northern Strait of Georgia. The quarterly sampling strategy allowed an evaluation of seasonal variability as well as geographical variation. Overall, river samples showed high absorption coefficients in summer and spring with lower values in fall. Absorption coefficients were highest in the Fraser River and lowest in the Cowichan River. There was a general trend to increasing absorbance from south to north. In contrast, the slope coefficient of CDOM absorption shallowed from south to north and from winter to summer. River discharge appeared to be the biggest seasonal driver in all the rivers sampled. The spectral slope coefficient of the Cowichan River approached that of marine samples, implying either significant phytoplankton production or photochemical fading in the headwater lake.

Marine absorption coefficients were lower than those observed for river water, but also showed seasonal signals, with highest values in summer (August) and lowest in autumn (November). A comparison of marine and freshwater end members will be used to evaluate conservative and non-conservative processes operating on CDOM within the Strait of Georgia.

4B1.4 ID:4986 11:30

A fair and equitable system for comparing the global models of the major NWP centres

Tom Robinson
Environment Canada
Contact: tom.robinson@ec.gc.ca

How do weather forecast models from the world's major NWP Centres, including Canada, stack up against each other? The WMO Commission for Basic Systems (CBS) operates a monthly exchange of deterministic model verification scores that could potentially answer this question. However, the goal of ensuring a fair and equitable comparison between models has become increasingly elusive, due in part to the evolution of NWP since the original exchange standards were implemented in 1998, but also to a growing divergence amongst the Centres in compliance with those standards.

The CBS has set up a Coordination Group on Forecast Verification (CG-FV), mandated with updating the system to ensure that it can give appropriate feedback on the performance of modern higher resolution global NWP models, to extend verification from the current upper air fields to surface fields such as QPF, temperatures and winds and to consider emerging forecast types such as probabilistic forecasts and nowcasting products as well as severe weather and warning verification.

This presentation will examine issues affecting the fair and equitable comparison between models, including the use and quality control of data, interpolation of model fields to verifying observation points or analysis grid and use of different climatologies for scores such as the anomaly correlation. The current and future work of the CG-FV in the area of surface and severe weather verification will also be addressed.

1B6.4 ID:4987 11:45

Characterisation of storms in Nunavik coastal regions for assessment of the vulnerability of coastal infrastructures to climate change

Jean-Pierre Savard , *Corina Rosu*
Ouranos
Contact: savard.jean-pierre@ouranos.ca

This study, sponsored by the Ministry of Transport of Québec was conducted by Ouranos and Environment Canada to assess the vulnerability of Nunavik coastal infrastructures to climate change and to develop adaptation responses. A storm-based analysis was use to evaluate extreme conditions that may affect water level and wave patterns in a future climate as damage to coastal marine infrastructures is mostly caused by storm events that enhance extreme water levels and large waves propagating to the coastal zones. In arctic coastal areas such as Hudson Bay, Hudson Strait and Ungava Bay, the highly dynamic ice regime must also be consider as this affects the frequency and intensity of surges and waves. The complexity of these processes requires the application of hydrodynamic models, fed by climate models to compute future conditions of extreme water level, waves and shore ice. The spatial and temporal scales involved in these processes are much finer than those included in climatic and hydrodynamic models, and introduce large uncertainties that complicate the generation of relevant information for decision makers. A storm-based analysis provides a way to integrate the various time and spatial scales and is a physically-based approach to exploit the physics in climate and hydrodynamic models. A storm tracking program (Sinclair algorithm) was applied to characterize storminess in the Nunavik coastal region generated by climate models. Information on the position, speed and direction of the storm centre, and the intensity and spatial dimension of the storms were determined and this information compared for different climate models, different model ensemble members and different emission scenarios for past and future climates. The storm analysis was then used to explain the behaviour of storm tracks in a warmer atmosphere, and to examine changes in storm winds and the resulting impacts on surges and waves. This synoptic-scale approach to climate change impact analysis was found to be instrumental in building confidence in the modelling process and in adding coherence to understanding the interactions taking place over a range of various scales.

4B0.4 ID:4989 11:15

Biosphere-atmosphere exchange at a mixed hardwood forest in Central Ontario subject to high nitrogen deposition

Jeffrey Geddes [1], *Jennifer Murphy* [1], *Carolyn Winsborough* [2], *Nathan Basiliko* [2], *Sean Thomas* [3], *Alex Petroff* [1], *Avila Desousa* [1]
[1] University of Toronto Department of Chemistry
[2] University of Toronto Department of Geography
[3] University of Toronto Department of Forestry
Contact: jeff.geddes@utoronto.ca

Forests cover almost a third of the earth's land surface, and have important feedbacks with regional and global climate through processes such as carbon exchange, evapotranspiration, surface roughness and albedo. Quantifying these roles involves measuring the exchange of carbon dioxide, water, and energy, while projecting their influence into the future also requires understanding the effects of nutrient input and pollutants. We have established a long-term monitoring site located at Haliburton Forest and Wildlife Reserve in central Ontario to study carbon and nitrogen cycling at a location where estimates of nitrate deposition are among the highest in the country. Previous observations at the forest, including fertilization studies, measurements of soil greenhouse gas fluxes, and precipitation chemistry, indicate the possibility the forest is reaching nitrogen saturation. This would have major implications for future greenhouse gas fluxes and sequestration. We report all-season tower-based eddy covariance measurements of CO_2, H_2O, and sensible heat exchange since August 2009, in conjunction with observations of air temperature, PAR, soil moisture, and soil temperature. These are complemented by measurements of soil greenhouse gas fluxes within the tower footprint, allowing us to estimate their contribution to fluxes measured above the canopy. Preliminary analysis shows this uneven-aged mixed-hardwood managed forest may have been a net carbon source, however canopy dieback during leafout in 2010 may have compromised photosynthesis throughout that year. Continued micrometeorological monitoring in future years will help determine both long-term net ecosystem exchange and inter-annual variability. We also present measurements of reactive nitrogen exchange, revealing processes and chemistry which are poorly understood or even excluded from current models. This work is aimed at improving our understanding of the interconnected nitrogen and carbon cycles, which have implications for future climate predictions, in a forest system subject to high levels of nitrogen deposition.

4C4.4 ID:4991 14:30

Practical application of satellite remote sensing to the coastal waters of Atlantic Canada

Gary Bugden [1], *Gordana Lazin* [1], *Brent Law* [1], *Edward Horne* [1], *Joel Culina* [2]
[1] Fisheries and Oceans Canada
[2] Acadia University
Contact: Gary.Bugden@mar.dfo-mpo.gc.ca

Recent advances in remote sensing techniques allow their application to practical problems in the coastal zone. Ocean colour data can be used to monitor nuisance algal blooms, determine the distribution of organic suspended particulate matter and delineate the influence of river plumes along the coast. Other sensors can be used to locate and describe water surface features diagnostic of circulation patterns to calibrate and verify numerical circulation models. Several examples are presented to illustrate these applications in the coastal waters of Atlantic Canada

2B5.2 ID:4992 11:00

A region of increasing hypoxia on the British Columbia Shelf

Bill Crawford , *Angelica Peña*
Inst. Ocean Sciences, Fisheries and Oceans Canada, Sidney, BC
Contact: bill.crawford@dfo-mpo.gc.ca

Low oxygen concentrations are characteristic of bottom waters off southwest Vancouver Island, British Columbia. However, in recent years the dissolved oxygen concentration in mid-shelf bottom waters has dropped to less than 1 millilitre per litre (~40 microMolar), with lowest concentrations in late summer of 2006 and 2009. Oxygen concentrations in these two years were the lowest observed in more than 40 years of observations. This region lies within the Juan de Fuca Eddy, a relatively stationary feature which rotates cyclonically in spring and summer. Numerical simulations and observations of this eddy reveal that deep water upwelling is enhanced in this region due to the proximity of the Juan de Fuca canyon. We suspect these recent declines are due mainly to lower oxygen concentrations in deeper water that upwells onto the shelf in spring and summer, and to a lesser extent on stronger upwelling winds off Vancouver Island in the past decade. Interannual variability in the degree of eddy retention might also be important. The declines in recent summers are part of a trend to lower oxygen concentrations in subsurface waters off Canada and the USA, and could lead to serious ecological problems in Canadian waters if they continue.

4B5.6 ID:4994 11:45

A review on acoustic estimation of migratory fish abundance in the lower Fraser River

Yunbo Xie
Pacific Salmon Commission
Contact: xie@psc.org

In-season management of Fraser River salmon fisheries requires daily acoustic estimation of salmon influx to the lower river. The monitoring site at lower river imposes a number of challenges for acoustic enumeration of fish passages both physically (large river width, debris and boat-wake noise, tidal influence, etc) and biologically (fish's behavioural responses to dynamic changes in the flow field, to the frequent in-river fishing activities and other predators such as harbour seals and adult white sturgeon, etc). The development of acoustic monitoring systems with both the split-beam and imaging sonar over the last 10 years has made a remarkable progress in meeting these challenges. This paper presents a review of sonar work on (1) enumerating fish flux and (2) identifying/verifying fish targets and behaviour.

4B6.4 ID:4995 11:30

Coupled ice sheet/climate simulations of Greenland evolution in coming millennia: ice volume evolution and sensitivity to model parameters

Jeremy Fyke [1], *Andrew Weaver* [1], *Andrew Mackintosh* [2], *Lionel Carter* [2]
[1] University of Victoria
[2] Victoria University of Victoria
Contact: jer@ocean.seos.uvic.ca

It is generally accepted that large continental ice sheets are sensitive to atmospheric CO_2. In order to contribute to assessments of Greenland Ice Sheet (GIS) evolution under elevated-CO_2 conditions, we used an ice sheet/climate model to simulate the coupled global climate/GIS system for multiple millennia under varying CO_2 concentrations. When initialized with a stable present-day GIS and run forward using default model parameters, the suite of model simulations predicted a limit on GIS stability between 3 and 4 times preindustrial atmospheric concentrations of CO_2 (based on a transition to a net negative surface mass balance during the course of model equilibration). However, transient simulations forced with CO_2 concentrations derived from long-term coupled-carbon simulations exceeded this criterion significantly without complete simulated GIS loss due to the ability of the ice sheet to weather transitory peak CO_2 concentrations. A hysteresis curve in ice volume-CO_2 space indicated the potential for multiple GIS states between 1-5x PAL CO_2. Additional experiments highlighted the large sensitivity of the results to prescribed lapse rates and surface albedo values, suggesting that well-constrained surface mass balance model parameters are required for robust predictions of future GIS behaviour, especially over timescales that are long enough for significant ice sheet evolution to occur.

4C5.1 ID:4996 INVITED/INVITÉ 13:30

Seasonal variability of phytoplankton production in the Straits of Georgia and Juan de Fuca

Angelica Pena [1], *Diane Masson* [2]
[1] Institute of Ocean Sciences, Fisheries & Oceans Canada
[2] Institute of Ocean Sciences, Fisheries & Oceans CanadaSeasonal variability of phytoplankton producti
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. Significant variability on a wide range of time scales has been observed in this region. In this study, we will describe the seasonal variability of this region using results from a coupled biogeochemical /circulation model (ROMS-Regional Ocean Modeling System) and field observations. In the Strait of Georgia, modeled phytoplankton biomass shows pronounced seasonal variability consistent with observations. Model and observations indicate maxima phytoplankton abundances in April, when the increase in solar radiation and abundance of nutrients provides optimal growing conditions. In the model, physical variability plays an important role in maintaining the high spatio- temporal variability of plankton abundance. For example, freshwater inflow and tidal mixing greatly influence the stability of the water column and the production of phytoplankton.

1B2.3 ID:4997 11:30

Designing the Foundations for Understanding the Past and Predicting the Future - The Meteorological Service of Canada’s Network Planning and Design Process

Alexander Zucconi
Environment Canada - MSC - MSSS
Contact: alexander.zucconi@ec.gc.ca

The Meteorological Service of Canada’s (MSC) monitoring networks provide observations that support Canada’s most fundamental weather and climate information needs. To help ensure these networks remain pertinent as the evolving demand for information continually grows, the MSC has formalized a strategic network planning and design process. This process is an adaptation of the World Meteorological Organization’s internationally recognized Rolling Requirements Review. The

purpose is to develop integrated weather and environmental monitoring solutions to ensure the evolving requisite requirements are met in a manner which is scientifically rigorous, reliable and sustainable.

The process places a strong emphasis on collecting and validating user requirements, analyzing current monitoring capabilities, identifying discrepancies (e.g. gaps), assessing monitoring alternatives and developing network design options. The process is cyclical in nature and will be repeated regularly; its adaptable nature allows for it to be reapplied as necessary in response to shifting mandates, evolving requirements and emerging monitoring capabilities.

The fundamental initial step of the process is developing a clear understanding of user requirements. The current focus of the requirements gathering initiative is the MSC's severe weather warning program. Initial findings reveal these requirements vary by region across Canada's diverse landscape; with linkages to synoptic and meso-scale weather patterns, local weather effects, population densities, and transportation corridors.

The many environmental monitoring networks owned and operated by other public and private organizations are recognized by the MSC as an excellent potential opportunity to help address defined requirements. Coordinating these multiple data sources into a coherent national system so that the information is useable and beneficial for the community at large is an objective of the development of a Canadian Network of Networks.

A general overview of the planning process and recent progress will be presented.

4B5.5 ID:4998 11:30

One year of detecting fish movements with a Doppler profiler on the VENUS Ocean Observatory

Len Zedel
Memorial University of Newfoundland
Contact: zedel@mun.ca

Through processing of individual beam data, it is possible to separate fish and water velocities in Doppler profiler data. Since June 12, 2010, continuous data suitable for such processing has been available from the VENUS Ocean Observatory, Georgia Strait East Node. A summary of those observations are presented. A variety of behaviours are seen in the data with some appearing throughout the year and others being restricted to particular seasons. At all times there is a strong diurnal signal in backscatter driven by the movements of the deep scattering layer (DSL). There is a clear association of discrete acoustic targets (fish) that track the DSL movements. In addition, there are times when well defined fish schools occur outside of the DSL. The observations coincide with this years record high return of Fraser River sockeye salmon but there is no clear signature from those fish in the data.

4B2.2 ID:4999 10:45

Climate model internal variability – the uncertainty required for adaptation

Marco Braun [1], *Daniel Caya* [2], *Anne Frigon* [2], *Laxmi Sushama* [1]

[1] Université du Québec à Montréal - UQÀM
[2] Consortium Ouranos, Montréal, Québec
Contact: Braun.Marco@sca.uqam.ca

The internal variability of climate models entails an uncertainty to model output that cannot be reduced. Representing the chaotic nature of the climate system it is actually a desired feature in any atmospheric simulation. Regional adaptation to climate change often relies on climate model results to assess impacts and develop adequate strategies. The impacts and adaptation community therefore needs to be aware of the presence of internal variability in the applied data. With a focus on watersheds across Canada the difference of global and regional climate models' internal variability and the resulting uncertainty is presented using simulations performed with the Canadian Regional Climate Model (CRCM). Global climate model (GCM) internal variability is addressed by using multiple GCM members as lateral boundary conditions (LBC) to drive the CRCM runs. CRCM internal variability is is assessed by perturbing initial conditions without changing the LBCs. Factors impacting on CRCM internal variability include the choice of regional simulation domain, location within the domain, size of the studied site and the way the boundary conditions from the GCM are applied to the RCM (e.g. large scale nudging, sponge layer, etc.). Along with a discussion of these factors, a practical approach to estimate internal variability for regional impact and adaptation applications at the watershed level is presented.

4C6.5 ID:5000 14:30

Prediction of High Impact Events on Wind Power Productions

Wei Yu [1], *Sarah Dyck* [1], *André Plante* [2], *Julien Choisnard* [3], *Alain Forcione* [4]
[1] Numerical Prediction Research Section, Science and Technology Branch, Environment Canada
[2] Meteorological Service of Canada, Environment Canada
[3] Hydro-Québec Distribution (HQD), Hydro-Québec
[4] de recherche d'Hydro-Québec (IREQ), Hydro-Québec
Contact: Wei.Yu@ec.gc.ca

Weather extremes can cause sudden changes in power production and damage to wind turbines. The prediction of high impact events is thus of vital importance for wind power integration and wind plant management. The wind power plants in the Gaspe region of Quebec often experience rapid changes in wind speed due to mountain waves and turbine stoppages due to turbulent air flow.

Forecast indexes were developed to predict these phenomena. The Froude Number is a useful index for the onset of mountain waves. Preliminary results show that a majority of mountain wave events can be detected using output from GEM-LAM configured to run over a 2.5km resolution grid. Turbulent Kinetic Energy (TKE) predicted by the model was found to correlate well with stoppage events, in term of number of affected units within a wind power plant, when certain threshold values are exceeded. Several turbine stoppage events were correctly predicted in a one year period. Due to the less frequent nature of these events, however a longer time series is needed to refine the thresholds and to validate the use of this indicator.

2E0.1 ID:5001 INVITED/INVITÉ 19:30

The North Pacific – An Ocean in Transition

Ken Denman
VENUS Coastal Network, School of Earth and Ocean Sciences, & EC CCCMA, all at U. Victoria
Contact: denmank@uvic.ca

For those of us living in Victoria, the sea is always close at hand. Yet only if we travel to the west coast of Vancouver Island do we actually see and experience the North Pacific Ocean, which provides us with our weather, our climate, and the seafood we eat. Due to human activities, primarily the release of carbon dioxide gas to the atmosphere from the burning of fossil fuels, we are changing the North Pacific by making it warmer, more stratified near the surface, less oxygenated below the surface, and more acidic. Projections are that these trends will continue and accelerate during this century. In response, ocean ecosystems must change and adapt to the future North Pacific Ocean, but our projections of the structure and functioning of future ocean ecosystems are less clear. In this talk, I will show how dynamic and interconnected the weather, the climate and our oceans are. Emphasizing the North Pacific, I will show how the climate and our oceans are changing in response to human activities, and projections on how these changes will continue over the 21st century. In particular, I will present observations of near surface warming and increasing stratification, decreasing subsurface oxygen concentrations, and increasing carbon dioxide and the resulting acidification of the North Pacific Ocean, especially the coastal ocean along the North American shoreline. Finally, I will describe and illustrate how these changes will affect ocean planktonic ecosystems, and how these ecosystems might respond and adapt to their changing environment.

3C1.5 ID:5002 14:30

Automated Fog and Stratus Forecasts From the CMC RDPS Operational Model

William Burrows [1], *Garry Toth* [2]
[1] Environment Canada, Sci. & Tech. Branch, ARMP & HAL
[2] Environment Canada, MSC, Hydrometeorology & Arctic Lab
Contact: william.burrows@ec.gc.ca

Fog and low stratus depend on the characteristics of the boundary layer. However, the boundary layer poses particular problems for NWP models. Can the Canadian operational regional forecast model be used to make forecasts of fog and stratus that are useful to operational forecasters?

An automated system to forecast fog (visibility ≤ ½ mile) and low stratus (ceiling ≤ 500 feet) has been developed at the Meteorological Service of Canada s Hydrometeorology and Arctic National Lab (HAL) in Edmonton. It applies a set of subjectively-developed rules for various types of fog to output of the Canadian Meteorological Centre (CMC) RDPS operational model over Canada and the adjoining marine waters. The model bulk Richardson number is used to differentiate between fog and stratus. Hourly forecasts from 1 to 48 hours are produced at 12Z and 00Z. Hourly summary charts of land observing stations with fog or low stratus and ships with low visibility in fog were used in development.

The following evaluations have been done: 1. on-going subjective verifications during the development process 2. informal verifications by local operational forecasters who use the product 3. subjective verifications by forecasters in Halifax 4. subjective verification for the ship Healy in the Arctic Ocean in summer 2009 5. on-going objective hourly verification of the forecasts at land stations.

The subjective verifications agree that the system has a good degree of skill. Some operational meteorologists have become familiar with the system and find it is useful as a “first guess” field for fog and low stratus. They like the hourly availability of the forecasts. The subjective verifications indicate the system over-forecasts fog and stratus to some degree, particularly in the warm season. This is accepted as a price to pay for fewer misses.

The system has an experimental status. It runs locally in Edmonton, and is not supported 24/7. Our hope is for its eventual implementation as a fully-supported operational at CMC.

4B4.4 ID:5003 11:30

The tilt of mean sea level along the east coast of North America: Can it be explained by the large scale ocean circulation?

Simon Higginson [1], *Keith Thompson* [1], *Marc Véronneau* [2], *Jianliang Huang* [2], *Youyu Lu* [3]

[1] Dalhousie University
[2] Geodetic Survey Division, Natural Resources Canada
[3] Bedford Institute of Oceanography
Contact: simon.higginson@dal.ca

The mean sea surface topography (MSST), and hence the mean surface geostrophic circulation, can be estimated using a geoid model and a satellite altimeter-derived mean sea surface. Near to shore, where the accuracy of the satellite altimeter measurements is lower, tide gauges referenced to a common geodetic datum provide an alternative estimate of mean sea level. Earlier work identified tilts of MSST along the east coast of Canada and along the US east coast south of Cape Hatteras. We calculate MSST using a new geoid model, developed by Natural Resources Canada, and tide gauge data from 29 stations between 24°N and 48°N for the period from 2000 to 2009. We will show that the improved accuracy of the geoid model removes the tilt along the Canadian coastline but a tilt remains south of Cape Hatteras. We will investigate the connection between the large scale ocean circulation and the coastal sea level tilt using an ocean model, and consider whether there is an opportunity to use tide gauges to monitor aspects of the surface circulation of the deep ocean.

1B4.2 ID:5004 11:15

Hydrographic and circulation study in Hermitage Bay/Bay d'Espoir, Newfoundland

Andry William Ratsimandresy , *Julio Salcedo* , *Danny Ings* , *Gehan Mabrouk* , *Fred Page* , *Dwight Drover* , *Randy Losier* , *Paul Mccurdy*
Fisheries and Oceans Canada
Contact: andry.ratsimandresy@dfo-mpo.gc.ca

Finfish aquaculture in Newfoundland is centred on the south coast of the island and is expanding rapidly along the coast. The oceanographic conditions of the area have a great impact on the viability and sustainability of the finfish farms, but relatively little is known about variability in the oceanographic processes in the complex arrangement of fjords and bays where the farms are located. To address the knowledge gap, oceanographic measurements have been carried out for the last 2 years (2009-2010) focusing first on the summer and fall conditions. Various instruments were deployed at different locations of the fjords and bays to measure temperature, salinity, dissolved oxygen, as well as current at the surface and at depths. The distribution of different oceanographic variables as well as the ocean currents are presented and a tentative description of the water circulation in the area is provided. A cold sub-surface layer is found all year long with the thickness and depth changing depending on the season.

4C0.1 ID:5005 13:30

Photochemical Production of Dissolved Inorganic Carbon from Three Algal Cultures: Implications for Iron Fertilization

Eduardo Loos , *Sophia Johannessen* , *Angelica Peña* , *Robie Macdonald*
Institute of Ocean Sciences, Fisheries and Oceans Canada - P.O.Box 6000, Sidney, BC, V8L 4B2, Canada
Contact: Eduardo.Loos@dfo-mpo.gc.ca

Iron fertilization of seawater in high nutrient, low chlorophyll regions of the ocean, such as the northeast subarctic Pacific, causes a temporary increase in phytoplankton production, which draws down carbon dioxide (CO_2) and creates both particulate and dissolved organic carbon, including chromophoric dissolved organic matter (CDOM). Fertilization also alters the assemblage of phytoplankton, tending to favour large diatoms. Solar irradiation photo-oxidizes CDOM in surface ocean waters, producing carbon dioxide as dissolved inorganic carbon (DIC). This reaction could represent a negative feedback to the effectiveness of iron fertilization at drawing down carbon dioxide, if the efficiency of DIC production is greater for the CDOM released from the fresh algae than for that which was in the water before fertilization.

Photochemical experiments were conducted on surface seawater samples from Line P (northeast Pacific Ocean) and on three algal cultures (coccolithophorid, diatom and cyanobacterium), using a solar simulator. We will present a comparison of absorption-normalized DIC production rates, and apparent quantum yield spectra. In situ daily photochemical production rates, calculated from the quantum yield spectra, CDOM absorption coefficients, and modelled irradiance spectra, will be applied to the prediction of the effect of photochemical oxidation on the effectiveness of carbon dioxide drawdown by iron fertilization.

2C3.6 ID:5006 15:15

Seasonal controls on urban-rural differences of the surface radiation budget

Andreas Christen [1], *Tim Oke* [1], *James Voogt* [2]
[1] University of British Columbia, Department of Geography
[2] University of Western Ontario, Department of Geography
Contact: andreas.christen@ubc.ca

Urban areas cover a minimal fraction of Canada’s land surface (

Results show the yearly total shortwave irradiance was slightly reduced at the urban site (-4% relative to rural), which was mostly attributed to regional gradients in cloud cover rather than aerosol (no reduction under clear skies). The low albedo of the urban surface (0.12), compared to the rural site (0.18, caused significant reduction in shortwave reflectance in the city - especially in summer when water availability at the rural site was restricted and caused vegetation albedo to increase. Largest differences in reflectance were found with snow cover. The urban area received significantly more net shortwave radiation due to snow-free walls, snow removal and accelerated snowmelt. Incoming longwave radiation was generally enhanced over the urban site (+3%). The enhancement under clear-sky conditions showed a correlation with the intensity of the boundary layer urban heat island. Elevated urban surface temperatures (surface urban heat island) caused outgoing longwave emittance to be increased on the yearly average by 6% with higher monthly totals in summer (up to +9%) and less in winter (+3%).

On an annual basis, the urban site received slightly more shortwave input, but lost significantly more in the longwave, causing the total urban net allwave radiation to be lower (-12%) compared to the rural site. We conclude that differences depend strongly on the choice of a rural reference site, and seasonal dynamics in the surface state (snow, vegetation, soil moisture) and cloud cover.

1B4.6 ID:5007 12:15

A super-regional test-bed to improve wave models

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

We use the new multi-grid (mosaic) WAVEWATCHIII (hereafter WW3) ver. 3.14, and recent structured (ver. 40.51) and unstructured (ver. 40.81) versions of SWAN shallow water wave model, using fine-resolution grids (up to 50m near the inundation site) to investigate the role of waves and wave set-up in the case of inundation, when wetting and drying occur. Our studies will be compared with those of other state-of-the-art models from WHOI, U. Notre Dame, LSU, using coupled waves+tides+surge+ inundation models. Tests focus on the extra-tropical model test bed site in the Gulf of Maine, taking advantage of the in situ data available from buoys and other instrumentation. Tests would involve actual storms where inundation occurred, for example the Patriots Day Storm 2007, and the Boxing Day storm 2010, where high quality observed data are available for waves and water levels. Metrics would include standard and new statistical measures to assess model accuracy. Recommendations are made to improve wave simulations in composite model systems (waves+tides+surge+inundation) appropriate for ocean models used by the Team, coupled to wave models, for simulations of severe coastal storms.

2D5.5 ID:5008 17:15

Thriving in an oxygen minimum zone: proteomic analysis of SUP05 energy metabolism

Alyse Hawley [1], *David Walsh* [2], *Elena Zakiova* [1], *Charles Howes* [1], *Philippe Tortell* [1], *Angela Norbecck* [3], *Ljuljana Pasa-Tolic* [3], *Steven Hallam* [1]
[1] University of British Columbia
[2] Concordia University
[3] Pacific Northwest National Laboratory
Contact: alysekh@interchange.ubc.ca

Oxygen minimum zones (OMZs) are regions of low dissolved oxygen (hypoxia) that support an endemic microbiota whose metabolic activity impacts nutrient and trace gas cycling within the global ocean. The OMZ microbiome plays an important role in the nitrogen cycle as a biological nitrogen sink and a source of the greenhouse gas nitrous oxide. The differential contribution of denitrification, anammox and dissimilatory nitrate reduction to ammonia (DNRA) to nitrogen loss within seasonal and permanent OMZs is under intensive study. Recent work has demonstrated the ubiquitous and abundant presence of the SUP05 lineage of gammaproteobacteria in sulfidic and non-sulfidic OMZs. Metagenomic analysis of SUP05 revealed a versatile energy metabolism with multiple integrated pathways for sulfur oxidation and denitrification. Here we explore environmental and genetic factors regulating SUP05 energy metabolism using environmental proteomic approaches in the stratified water column of Saanich Inlet, a seasonally anoxic fjord on the coast of Vancouver Island British Columbia. By recruiting environmental peptides to the SUP05 genome sequence we identified differential gene expression in hypoxic and anoxic regions of the water column specifically related to the integration of sulfur-oxidation and nitrate reduction pathways. Additionally, we detected a c-type polyheme cytochrome related to hydroxylamine oxidoreductase with the potential to mediate DNRA

in anoxic basin waters. Collectively, these observations validate proposed models for SUP05 energy metabolism while uncovering previously unrecognized modes of electron transfer. These observations in turn provide a functional basis for constraining the ecological role of SUP05 in relation to sulfur detoxification and biological nitrogen loss in sulfidic and non-sulfidic OMZs.

1P602.2 ID:5009 16:00

British Columbia Forest Science Climate-Hydromet Research Network

Vanessa Foord , *Bill Floyd*
British Columbia Ministry of Natural Resources Operations
Contact: Vanessa.Foord@gov.bc.ca

Researchers with the British Columbia Forest Science Program, with help from various partners, have been collecting climate and hydrometric data for the past few decades. In recent years, an effort has been made to increase the number of weather stations and develop a formal research network of approximately 70 stations province-wide. Equipment was installed to answer a variety of forest research questions; however, the data may hold considerable value for climate change research. In many cases, these research sites fill gaps in British Columbia's operational weather and hydrometric networks, such as at northern and high elevation sites. Many sites have information beyond standard temperature and precipitation, such as snow data, soil temperature, and light conditions to name a few. We have teamed up with the BC Climate Related Monitoring Program to contribute this data to climate change research and modeling.

1B3.6 ID:5010 12:15

Changes of wave heights in North Atlantic Ocean under the IPCCAR4 scenario A1B

Lanli Guo [1], *William Perrie* [1], *Bechara Toulany* [1], *Zhenxia Long* [1], *Joel Chasse* [2]
[1] Bedford Institute of Oceanography
[2] DFO-Gulf
Contact: perriew@dfo-mpo.gc.ca

This study assesses the fall (September and October) seasonal mean and extreme (90 percentile) Significant Wave Height (SWH) change in the North Atlantic Ocean by using the wind field from CRCM dynamically downscale outputs. The wave model in this study is WAVEWATCH III version 3.14. Winds are always of key importance in any study of ocean waves. To consider the impacts of climate variability, we do dynamical downscaling to simulate winds related to extra-tropical cyclones in the Northwest Atlantic, and consider the variability of cyclone climatology, and the impacts of climate change following the A1B IPCC scenario. In this approach, (Long et al., 2010, Perrie et al., 2011) a relatively fine-resolution regional climate model is used to simulate cyclones and their climatology, in a century-scale run. For present climate, the integration was performed for 1970-1999; results give a relatively accurate description of marine winds and surface air temperature. The AES40 Hindcast wave climate data was used to assess the current wave climate. Winds were assessed with NCEP/NCAR, ERA40 and QSCAT and NCEP Blended Winds reanalysis data. Future climate is assessed for the period 2040-2069. Winds are used to drive the wave model WaveWatchIII to estimate climate effects on waters off eastern Canada. EOF analysis is used to show that decreases (increases) in highest significant wave heights for the Northwest Atlantic. In the future climate (2040-2069), the most important statistically significant findings are decrease in mean SWH in south of Iceland and an increase in the east North Atlantic Sea in extreme Significant Wave Height.

1B6.3 ID:5011 11:30

Application of Statistical Downscaling Model (SDSM) on Simulation of Precipitation during Hurricane Season in Toronto, Canada

Jerry Jien
university of toronto scarborough
Contact: 04jienje@utsc.utoronto.ca

The ability for the current General Circulation Models (GCMs) to simulate climate driver for extreme events such as tropical cyclone and generate scenario output of precipitation events is severely limited by their coarse spatial resolution. This paper will address an alternative approach, through statistical downscaling, to better simulate regional precipitation pattern in Toronto, Canada during the hurricane season from 1961 to 2100. Specifically, the statistical downscaling model (SDSM), is employed to build a regression-based model by establishing an empirical relationship of large-scale atmospheric variables (predictors) with the observed precipitation (predictand) data. Spatially gridded CGCM3-derived predictors under scenarios of A2 and A1b, as well as predictors from historic climate forcing under CGCM3 and of NCEP/NCAR re-gridded data serve as the initial input to the model. Results under such greenhouse-gas forcing from the Canadian model are compared with HadCM3-derived predictand under the initial hypothesis that atmospheric predictors derived from Canadian model simulate precipitation pattern in Canadian cities more accurate than its counterpart. Following the pre-screening and selection of predictors, model calibration and verification are tested to validate its ability to reproduce precipitation. This multiple linear regression model is extrapolated to forecast scenarios of precipitation amount, assuming such a predictor-predictand relationship is maintained overtime.

4C4.1 ID:5012 INVITED/INVITÉ 13:30

Satellite Observations of Canada’s Oceans – Current Activities by Fisheries and Oceans Canada

Helen Joseph
Fisheries and Oceans Canada
Contact: Helen.Joseph@dfo-mpo.gc.ca

Satellite Observations of Canada’s Oceans – Current Activities by Fisheries and Oceans Canada

Submission by: Helen Joseph, Director, Oceanography and Climate Science, Fisheries and Oceans Canada (DFO)

Canada’s three oceans encompass an area of approximately 7million square kilometres. This represents an area equivalent to about 70% of Canada's land mass. Conventional in-situ monitoring of this ocean area would be difficult and costly. Fisheries and Oceans Canada is actively exploring the use of satellite-based data, combined with conventional ocean monitoring, as a means to monitor Canada’s oceans. 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 satellite observing 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 address the demands of policy and decision-makers efforts across Canada's oceans and waterways.

3P701.3 ID:5013 15:30

Seasonal Soil Respiration (CO2 Eflux) Rates for Three Recently Harvested Ontario Boreal Forest Sites -- Canadian Carbon Program (CCP)

Phillip Reynolds , *Nick Payne* , *Gordon Brand*
Natural Resources Canada, CFS
Contact: preynold@nrcan.gc.ca

Soil respiration was measured monthly May through October 2010 for three recently harvested Ontario boreal forest sites. These consisted of two Fluxnet Canada boreal mixedwood sites (Childerhose and McKeown Lake) located near Timmins, Ontario and one of six Ontario Long-Term Soil Productivity (LTSP) jack pine sites (Wells) located near Wairncliff, Ontario. The Wells Plantation was harvested in 1993 and then replanted with jack pine following various harvesting and site preparation methods. This study reports on the tree length (TL) harvested and disc-trenched (DT), non-herbicide (NH) treatment sub-plots, deemed to be the most similar to harvesting and site preparation methods used at the other two Flux sites. The Childerhose plantation is approximately 20 years old (mid chronosequence Flux site) and consists of planted black and white spruce with natural regeneration spruce, balsam fir, white birch, and trembling aspen mixed in. The McKeown Lake site was harvested in the winter of 2009 (now the youngest chronosequence site), and previously a drier 80-year old mixedwood site consisting of white and black spruce, balsam fir, yellow and white birch, and trembling aspen. To date this site has not been planted and consists of natural regeneration of the above species. Both Timmins Flux sites are characterized by silt loam soils on more topographically elevated and drier sites, whereas the Wells plantation is characterized by sandy loam soils on a drier elevated site. Soil respiration values peaked in July, declining thereafter for all sites. Mean values for Childerhose, McKeown, and Wells, respectively were 4.72, 4.19, and 3.16 umol.m-2.s-1 CO2 in June; 6.81, 5.45, and 5.54 umol.m-2.s-1 CO2 in July; and 5.30, 4.00, and 4.03 in umol.m-2.s-1 CO2 in August. These data suggest no significant differences between any of the three planatation sites at any of the measurement times, but nominally speaking, the most recently harvested site (McKeown) has the largest values, and the sandy loam jack pine site (Wells) tends to have the smallest values, with the two silty loam spruce sites having slightly larger values. However, the lack of statistical differences between the sites suggests that for modeling purposes, a generalized curve could probably be fit to all of the data to adequately describe soil respiration rates for a wide range of drier boreal forest types and soils that have been recently harvested (roughly 1-20 years) and reforested.

3C2.3 ID:5015 14:15

Identifying an empirical downscaling strategy for Ouranos: A balance between reliability and flexibility

David Huard , *Diane Chaumont*
Ouranos
Contact: david.huard@gmail.com

Due to inherent biases in global as well as regional climate simulations, direct model output are generally not used directly as inputs to hydrological models, which are calibrated over observational data sets. These biases occur because of model errors, but also because the scales of model variables is so different from the scale at which observations are taken. Many empirical and statistical

downscaling techniques with varying levels of complexity have been devised to reconcile the model scale with the observational scale, while at the same time correcting existing biases. At Ouranos, a consortium providing climatological expertise to government, academia and industry, we are faced with the challenge of selecting a downscaling method that will address the varied needs of many different users. The method must be reliable, computationally efficient, easy to communicate to users and compatible with global and regional climate outputs. Following a review of different approaches, we selected two similar yet orthogonal downscaling techniques based on quantile mapping. These methods target daily variables, a requirement for most hydrological applications. The main advantage of using two methods is the ability to assess the robustness of results to the choice of downscaling method. An important downside of the quantile mapping approach in its current state is that it is one-dimensional. Applying the quantile mapping method on many variables independently causes modifications to the dependence structure between those variables. For example, downscaling of minimum and maximum daily temperatures sometimes lead to daily minima being larger than maxima. Solutions to extend quantile mapping approaches to the multidimensional case are discussed in the context of hydrological modelling, where daily precipitations and temperatures need to be downscaled.

1B0.4 ID:5016 12:15

Improved Accuracy in Measuring Global Distribution, Circulation and Sequestration of Greenhouse Gases Utilizing Top-Down and Inverse Modeling Approaches

James Anderson
Vice President, Global Networks and Business Development
Contact: shumenik@earthnetworks.com

Across the spectrum of environmental research and study, scientists agree that with more measurement come better science. Currently, only about a few dozen atmospheric observation instruments exist worldwide, which represents an inadequate number to assess CO2 and methane levels. As a result, greenhouse gas levels are primarily estimated using a bottom-up approach where ground measurements are used; thus only providing a partial measurement. Companies and countries currently base their emissions calculations on raw materials that are used in manufacturing or energy generation, rather than the actual amount of gases released as a result. This approach makes it difficult to evaluate the effectiveness of global initiatives.

A new top-down approach is now introduced for measuring greenhouse gas levels whereby actual atmospheric measurement is utilized to determine the carbon level, regardless of source. Weather and wind patterns have a profound effect on CO2 measurements. By measuring the atmosphere, a more accurate reading can be obtained for enhanced calculations. The Earth Networks Greenhouse Gas Observation Network (GHG) provides site specific live weather and GHG data (comparing carbon dioxide and methane levels to global averages) as well as historical graphs, 3D animation and carbon source maps.

This presentation will focus on the coupling of top-down and inverse modeling approaches utilized to provide a far more accurate picture of gases emitted and travel flow through weather currents enabling the understanding of the global distribution, circulation and sequestration (“carbon sinks”) of gases based on measurements of their actual accumulation in the atmosphere. Discussion around inverse modeling involving coupling of greenhouse gas measurements with computer models of regional atmospheric transport and update processes on a localized basis will also be provided.

2C4.5 ID:5017 15:00

Comparative assessment of a two-layered and a multi-layered sediment model.

Robin Wilson
Department of Oceanography, Dalhousie University
Contact: robin.wilson@dal.ca

Coastal sediments are in continuous interaction with the overlying water column, collecting and decomposing the incoming rain of organic detritus into inorganic nutrients, and consuming oxygen in the process. Here we compare the ability of two qualitatively different sediment models, a two-layered and a multi-layered model, to quantify the biogeochemical transformations that occur when detritus is decomposed in the sediment. We have optimized both models by estimating unknown model parameters as well as organic matter inputs to the sediment by means of parameter optimization using an evolutionary algorithm. This method represents a systematic way of minimizing the misfit between model simulations and observations. The observations are from a mesocosm eutrophication experiment carried out at the University of Rhode Island's Mesocosm Experimental Research Laboratory. We have optimized selected model parameters and the mean depositional fluxes of organic matter. Simulations with constant depositional fluxes outperformed simulations where deposition was dependent on proxies of biomass concentration in the overlying water. Given optimal depositional fluxes, both models produced similar nutrient fluxes across the sediment-water interface, although the two-layered model was able to match the observation slightly better. Both models show an increase in nitrification and denitrification rates under more eutrophic conditions.

2B3.6 ID:5018 11:45

Data transfer and data processing for the national AQHI forecast program

David Anselmo , *Paul-André Beaulieu* , *Samuel Gilbert*
Meteorological Service of Canada
Contact: david.anselmo@ec.gc.ca

The national Air Quality Health Index (AQHI), which was initiated in the summer of 2007, is an information tool that communicates to the Canadian public the total health risk of a mixture of the air pollutants nitrogen dioxide, ground level ozone, and fine particulate matter. As of May 2011, the AQHI forecast program is active in 49 communities across Canada serving more than 90% of the population.

In order to provide hourly observations and twice-daily forecasts of the AQHI to Canadian citizens and numerous other clients (e.g. media, regional partners, and health organizations), a substantial data transfer and data processing infrastructure has been established. This presentation will provide an overview of this system covering all of the essential, interdependent components. On the observation side, these include: the transfer of observations from regional observation networks to the Canadian Meteorological Centre (CMC) and the generation of observation related products for operational forecasters, Environment Canada's public web site (http://airhealth.ca), the ATADS telephone dissemination service, and regional partners. On the forecast side, these include: the cycling of the Canadian operational air quality forecast model (GEM-MACH15), the integration of other guidance from tools such as the UMOS statistical post-processing system and a surface objective analysis, as well as the generation of forecast products for the forecasters and the public. Additionally, we will present the internal Environment Canada web site that integrates all of these pieces of information into a single resource for forecasters.

The primary objective of this presentation is to provide the AQHI community with a better

understanding of the capabilities, challenges, and opportunities of the complex machine that serves as a major technical pillar in the foundation of the national AQHI program.

1C3.1 ID:5019 14:00

Simulation of seasonal and decadal-scale variability in the Caspian Sea

Paul Budgell [1], *Ralf Toumi* [2], *James Farley-Nicholls* [2]
[1] MariClime Numerics Inc.
[2] Dept. of Physics, Imperial College London
Contact: admin@mariclime.com

The Caspian Sea, the world's largest enclosed water body, has exhibited dramatic variations in sea level over the past century. Future climate projections from IPCC AR4 model results indicate that the Caspian Sea Level (CSL) may fall by as much as 8 m. Such a drop in the CSL would dry nearly the whole Northern Basin of the Caspian, with dire environmental consequences.

Before attempting to downscale future climate scenarios for the Caspian, we wish to understand previous swings in the CSL and to develop confidence that we can reproduce the variability in the Caspian Sea physical environment under existing climate conditions. To examine seasonal and decadal-scale behaviour of the Caspian Sea, a hindcast simulation is conducted for the period 1958-2001 using the coupled ice-ocean Regional Ocean Modelling System (ROMS) forced with ERA40 atmospheric reanalysis data. Using available river discharge data and a conventional bulk flux algorithm for latent heat transfer produced a bias in CSL trend of +6 cm/yr. The sensitivity of the Caspian water balance to evaporation of river runoff downstream of gauging stations, enhanced evaporation due to wave action, mesoscale variability in air-sea fluxes and changes in Caspian surface area are addressed.

3P405.1 ID:5020 15:30

Skill of CHFP2 multi-seasonal forecasts: Comparison with ENSEMBLES, NCEP CFS and Environment Canada’s current operational system

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

The performance of the CHFP2 coupled multi-model climate forecast system developed under the Global Ocean-Atmosphere Prediction and Predictability research network (GOAPP) and currently being adapted for operational use is compared with coupled forecasts from other seasonal prediction centres as well as two-tier forecasts from Environment Canada’s current operational system.

CHFP2 skill is compared with that of coupled model predictions from models participating in the EU ENSEMBLES project (ECMWF, IFM-GEOMAR, Meteo-France, UKMO HadGEM2, UKMO DePreSys, CMCC-INGV) and with NCEP CFS. The 25 years from 1981 to 2005 are considered for 7-month forecast periods commencing in February, May, August and November. Monthly/seasonal forecast skills for ENSO and other climate variables (surface air temperature and precipitation) are compared, and the relationship between ensemble spread and forecast error will be discussed. CHFP2 skills relative to Environment Canada’s current two-tier operational system are also briefly described.

4B3.4 ID:5021 11:15

On the dynamics of an abrupt climate change

Brian Rose [1], *David Ferreira* [2], *John Marshall* [2]
[1] University of Washington
[2] Massachusetts Institute of Technology
Contact: brose@atmos.washington.edu

A complex coupled atmosphere-ocean-sea ice climate model with idealized continental configurations has previously been shown to exhibit multiple stable equilibria: a warm, equable, ice-free state; and a cold state with sea ice extending into mid-latitudes. Here we focus on the transient adjustment of the global climate system between these very different states. We describe very long integrations (many kyr) of the coupled model with prescribed slowly-varying radiative forcing (± 5 W m^{-2} in the global mean), and the resulting hysteresis associated with large expansions and retreats of sea ice.

The transitions are complex, exhibiting threshold behavior and multiple time scales. The cooling phase is characterized by the initial appearance of a meta-stable small ice cap, followed by an ice-free period lasting several hundred years, followed by a rapid expansion of sea ice into the mid- latitudes. The warming phase begins with a slow retreat of sea ice on the kyr scale, followed by a rapid warming and total sea ice loss within about 100 years. The dynamics of these transitions are governed by complex interactions between the upper ocean stratification (build-up and decay of a halocline), deep ocean convection, and the large-scale convergence of ocean heat transport. We will discuss the extent to which these idealized experiments might shed light on the dynamics of D-O events.

1P201.3 ID:5022 16:00

Improved Wintertime Measurements with the CANDAC Rayleigh-Mie-Raman Lidar at Eureka, Nunavut

Christopher Perro [1], *Graeme Nott* [1], *Jonathan Doyle* [1], *Colin Pike-Thackray* [1], *Jason Hopper* [1], *Emily Mccullough* [2], *Thomas Duck* [1], *James Drummond* [1]
[1] Dalhousie University
[2] University of Western Ontario
Contact: christopher.perro@gmail.com

The CANDAC Rayleigh-Mie-Raman lidar (CRL), located in Eureka, Nunavut (80N, 86W) is an eight-channel lidar measuring ultraviolet and visible elastic and nitrogen Raman backscatter, water vapour mixing ratio, tropospheric temperature, and depolarization ratio profiles. Measurements of particle extinction and backscatter at two wavelengths means the colour ratio can be calculated, allowing differentiation between fine and coarse mode particles. For the instrument's second intensive measurement campaign, over the 2010/11 winter, significant improvements were made in the data collection and processing, leading to significantly enhanced measurement capability compared with the previous winter. New measurements shall be presented to illustrate these improvements.

Combined analogue and photon-counting elastic backscatter measurements were implemented resulting in an increase in signal dynamic range of 2 orders of magnitude. A corresponding increase in temporal resolution from 10 to 1 minute was seen. Overlap and differential overlap corrections based on a theoretical clear-sky return have been applied, this enables accurate profiles of aerosol extinction to be measured down approximately 200m. A new clear-sky normalisation procedure has also been implemented, reducing clear-sky variance by 2 orders of magnitude in backscatter coefficient profiles.

Aerosol measurements, using the improved analyses, along with depolarisation ratio, water vapour mixing ratio, and temperature from the winter 2010/11 campaign will be shown. Case-study data illustrating mixed-phase clouds, precipitating cirrus clouds, and aerosol–water vapour interactions will be shown along with a season-long time series.

4B0.3 ID:5023 11:00

Evaluating the effects of climate change and increasing CO2 on carbon budget of Chinese terrestrial ecosystems using processed model

Qiuan Zhu [1], *Hong Jiang* [2], *Changhui Peng* [1], *Jinxun Liu* [3]
[1] Institiute of environment sciences University of Quebec at Montreal, Canada
[2] International Institute for Earth System Science, Nanjing University, China
[3] Stinger Ghaffarian Technologies (SGT, Inc.), USA
Contact: qiuan.zhu@gmail.com

The possible response of the carbon budget of Chinese terrestrial ecosystem to climate change and increasing CO2 concentration was investigated though a series of simulations using Integrated Biosphere Simulator (IBIS). Two climate change scenarios (CGCM3-SRESA2, and CGCM3-SRESB1) were used to drive the model with CO2 emission scenarios of Sresa2, and Sresb1 respectively. With different assemblage of climate data and CO2 concentration, ten simulations were applied for the period of 1900 to 2099 in this study. The historical period was simulated with the observed climate data and CO2 concentration and model validation was carried out based on this historical simulation results. The validation showed a reasonable agreement between the model results and plot and flux observation data. The net primary productivity (NPP), above ground net primary productivity (ANPP), Gross primary productivity (GPP), net ecosystem productivity (NEP), soil respiration, soil carbon stock, and vegetation carbon stock (Biomass) were analyzed to explicitly evaluate the effects of climate change and CO2 fertilization on future carbon sequestration in terrestrial ecosystem of China. Our results indicated that the terrestrial ecosystem of China acted as carbon sink with value about 0.1 ~ 0.2Gt C yr-1 during the period from 1900 to 2008 in all climate change simulations. During the period of 2009 to 2099, different spatial and temporal carbon source and sink patterns were presented under different scenarios (climate change alone, climate change and rising CO2 concentration combined, rising CO2 concentration alone). Overall, the terrestrial ecosystem of China will act as carbon sink in 21st century with the values ranging from 0.06 Gt C yr-1 to 0.38 Gt C yr-1 for different assembled scenarios in this study.

2B4.3 ID:5024 11:00

Investigating far-field effects of tidal in-stream energy extraction in the Minas Passage on tidal circulation in the Bay of Fundy and the Gulf of Maine using a nested-grid coastal ocean circulation model

Daisuke Hasegawa [1], *Jinyu Sheng* [1], *David Greenberg* [2], *Keith Thompson* [1]
[1] Department of Oceanography, Dalhousie University
[2] Bedford Institute of Oceanography
Contact: jinyu.sheng@dal.ca

A two-way nested-grid coastal ocean circulation model based on the Princeton Ocean Model is used to investigate effects of tidal in-stream energy extraction in the Minas Passage on the three-dimensional (3D) tidal circulation in the Bay of Fundy and the Gulf of Maine (BoF-GoM). The nested-grid model consists of a coarse-resolution (~4.5 km) parent sub-model for the GoM and a high-resolution (~1.5 km) child sub-model for the BoF. The tidal in-stream energy extraction in the model is parameterized in terms of a non-linear Rayleigh friction in the momentum equation. A suite of numerical experiments are conducted to determine the ranges of extractable tidal in-stream energy and resulting

effects on the 3D tidal circulation over the BoF-GoM in terms of Rayleigh friction coefficients. The 3D model results suggest that the maximum energy extraction in the Minas Passage increases tidal elevations and tidal currents throughout the GoM and reduces tidal elevations and circulation in the upper BoF, especially in the Minas Basin, which are in good agreement with previous numerical studies. The far-field effect of tidal energy extraction in the passage on the 3D tidal circulation in the BoF-GoM is examined in two cases of harnessing tidal in-stream energy from (a) the entire water column and (b) the lower water column within 20 m above the bottom in the Passage. The 3D model results demonstrate that tidal in-stream tidal energy extraction from the lower water column has much less impacts on the tidal elevations and circulation in the BoF-GoM (up to 11% elevation reductions in the Minas Basin and less than 3 % of tidal elevation increases in the GoM) than the energy extraction from the whole water column in the Passage for the maximum energy extraction cases.

4C5.4 ID:5025 14:30

Habitat drivers of organic biomass inventory and production of benthos in the Strait of Georgia

Brenda Burd [1], *Tara Macdonald* [2], *Sophia Johannessen* [2], *Albert Van Roodselaar* [3], *Robie Macdonald* [2]
[1] Institute of Ocean Sciences, Sidney, BC Canada
[2] Institute of Ocean Sciences
[3] Metro Vancouver
Contact: burdb@dfo-mpo.gc.ca

We have been investigating the role of benthic biota in carbon cycling and in carbon inventories throughout the Strait of Georgia as a component of a collaborative project between Metro Vancouver and Fisheries and Oceans Canada. The purpose of the program is to develop understanding relevant to the design of monitoring. As such, our approach has been to study the functioning of the background system to provide a context that would allow the identification of change to habitats and biota resulting from anthropogenic inputs of carbon and other substances from outfalls and other sources. Ultimately, we seek to produce models that allow prediction and assist management of human activities that impinge on the Strait.

Benthic communities in the Strait of Georgia include a diverse array of species, exhibiting a wide range in organic biomass and sediment production levels. We discuss the relationships between benthic organic biomass/production and habitat drivers (depth, sediment type, organic flux and quality) throughout the Strait. Measured habitat factors can explain 70-75% of the variance in benthic biomass and production in background areas (away from direct anthropogenic input) of the Strait. The remaining variability seems to be related to spatially complex patterns in inorganic flux, long-term changes and short-term events (climate-related) affecting, for example, bottom oxygen conditions. Results of this work are discussed in the context of decadal patterns in habitat and production in the receiving environment of the Iona outfall off Vancouver.

4D4.1 ID:5026 15:30

National SAR Winds Project in Canada

Vladimir Zabeline [1], *Laurie Neil* [1], *Shahid Khurshid* [1], *Chris Fogarty* [1], *Sergey Komarov* [1], *Werner Reiche* [2]
[1] MSC
[2] contractor
Contact: vladimir.zabeline@ec.gc.ca

The Meteorological Service of Canada, Environment Canada is leading the National SAR Winds pilot project (2009-2011) which is providing near-real-time delivery of marine wind measurements derived from space-borne synthetic aperture radars (SAR) to the scientific community. The Wind Information Processing System (WIPS) for quasi-operational surface wind speed retrieval over Canadian and adjacent U.S. waters has been implemented and continues to undergo development. The system operates with RADARSAT-1, RADARSAT-2, and ENVISAT satellite imagery with very high resolution (100 m), and is able to map wind speed distributions with better than 1 km resolution even in coastal zones where orographic impact on wind patterns is very pronounced.

Based on the successful MENTOR project conducted during 2006-2008 in Pacific and Yukon Region, this Canadian Space Agency funded project extends the use of SAR Winds to all marine regions in Canada including METAREAs. 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 determination of the optimum system architecture for a proposed on-going, operational processing and dissemination system, and recommendations regarding implementation of such a system. To this end, partnerships have been developed between all MSC Regions, CMC, and the Canadian Ice Service to ensure the project objectives are met. MSC science divisions in the regions, particularly the National Labs, are also participating along with all the regional Storm Prediction Centers and 3 National Weather Services forecast offices in the U.S. Communication tools have been established to encourage interaction and facilitate learning amongst users. Training of the end users is another integral component of the project. Note that a similar project is underway in the United States (NOAA).

This presentation will briefly review results of the project, describe activities and achieved objectives, and present examples showing benefits of the SAR Winds system. Promising scientific advances which should lead to continuing improvements of accuracy will also be touched upon.

4B5.1 ID:5027 INVITED/INVITÉ 10:30

Long-term methane flux measurements from underwater gas seeps using passive and active acoustics

Svein Vagle [1], *Robert Bowen* [2], *Scott Dallimore* [3], *Humfrey Melling* [1]
[1] Institute of Ocean Sciences, Department of Fisheries and Oceans
[2] Diversified Scientific Solutions
[3] Geological Survey of Canada
Contact: Svein.Vagle@dfo-mpo.gc.ca

Methane is a powerful greenhouse gas and there is a growing interest in determining the role underwater methane seeps, especially from degrading permafrost and gas hydrate environments, plays in climate change. Here we describe a novel approach to get at the methane flux from a middle sized seep at the pingo-like feature (PLF) Kopanoar in the Canadian Beaufort Sea using a listening device moored at the PLF for 12 months. The sound emitted by bubbles escaping from the seafloor is used to measure the variable flux rate. Interesting temporal variability in the flux is observed and the significance of the methane flux is interpreted using a bubble dissolution model and high-frequency acoustical backscatter observations. [This work is supported by Department of Fisheries and Ocean, Geological Survey of Canada, and the Program of Energy Research and Development (PERD)]

4B3.2 ID:5028 10:45

Topographic Drag in Ultra-Fine Resolution Global Simulations

Kevin Hamilton
International Pacific Research Center, University of Hawaii
Contact: kph@hawaii.edu

The drag due to the pressure gradient across topographic features is computed for high resolution global simulations performed with the Atmospheric GCM for the Earth Simulator (AFES) and the Nonhydrostatic ICosahedral Atmospheric Model (NICAM). The results are compared with those obtained when the full topography and pressure fields are smoothed, resulting in a determination of drag as a function of horizontal scale. The implications for parameterizing the surface drag in moderate-resolution GCMs is examined, and comparisons of the explicit results with the predictions of current parameterization schemes may be presented.

3B3.5 ID:5029 11:30

Development of transfer functions for paleoceanographical reconstructions in the North Pacific Ocean, based on dinocyst assemblages

Sophie Bonnet , *Anne De Vernal* , *Taoufik Radi*
Université du Québec à Montréal (GEOTOP-UQÀM)
Contact: s.bonnet@wanadoo.fr

Transfer functions constitute a powerful statistical method commonly applied to reconstruct past environmental conditions. Here, we use dinocysts as a proxy of sea-surface conditions for the summer and winter temperatures and salinities, the duration of the sea-ice cover as well as the annual primary productivity. Numerous studies permitted to develop a reference dinocyst database at the scale of the Northern Hemisphere. Most of the studies performed to date cover the North Atlantic Ocean, the Arctic Ocean, and the eastern Pacific margin. Therefore, reconstruct paleoenvironmental conditions in the North Pacific Ocean remains a challenge due to the lack of sites from northern and western areas. In order to develop the North Pacific Ocean database, we have integrated 48 new sites, from neritic to oceanic domains, including a few sites from the Okhotsk Sea. The main objectives of this study are (1) to determine the relationships between the dinocyst assemblages and the environmental parameters via canonical correspondence analyses (CCA), and (2) to test the accuracy and reliability of reconstructions (i.e., validation tests) obtained from transfer functions with the North Pacific (369 sites) and the entire Northern Hemisphere databases (1429 sites). CCA results show that all environmental variables (temperature, salinity, sea-ice, productivity) are interdependent. Nevertheless, a particularly high coefficient of correlation ($R^2=0.91$) demonstrates that summer temperatures constitute the most determinant parameter for the dinocyst distribution. Transfer functions using the modern analogue technique (MAT) were tested with both databases. The results show that the best reconstructions are obtained for the temperatures ($R^2>0.96$; Error of prediction of ±1.68°C). Winter and summer salinities are reasonably well reconstructed ($R^2>0.70$) in the salinity range above 27. Sea-ice ($R^2 \sim 0.86$) and the annual productivity ($R^2 \sim 0.80$) are also relatively well reconstructed with an error of prediction that may be partly associated with the intrinsic natural variability. Overall, validation tests done on the new n=1429 database provide accurate and reliable reconstructions and can be used safely for further paleoenvironmental studies. Nonetheless, it is still of primary importance to keep improving the North Pacific database to get reconstructions comparable to those of the North Atlantic Ocean.

3B1.3 ID:5030 11:00

Towards an operational Canadian regional ensemble prediction system.

Martin Charron [1], *Ronald Frenette* [2], *Normand Gagnon* [3]
[1] Recherche en prévision numérique atmosphérique
[2] National Laboratory for Severe Weather Meteorology
[3] Canadian Meteorological Centre
Contact: Martin.Charron@ec.gc.ca

In 2011, a regional ensemble prediction system (REPS) is to become operational at the Meteorological Service of Canada. The system's architecture is presented: an ensemble of stochastically perturbed GEM-LAM integrations provides short-range probabilistic forecasts over North America. Scientific and technical details are discussed, including the piloting strategy and the stochastic perturbation method. The forecast quality of various meteorological fields, such as temperature, winds, geopotential height, and precipitation, is objectively verified against observations using different probabilistic scores. Future research directions and applications are also discussed.

4D2.4 ID:5031 16:15

Statistical downscaling of historical land surface winds over the Canadian prairies and central Canada: exploring prediction skill.

Aaron Culver
University of Victoria - School of Earth and Ocean Sciences
Contact: culver@uvic.ca

A statistical downscaling approach based on multiple linear-regression is used to investigate the predictability of land surface winds over the prairies and central Canada. This study's model downscales mid-tropospheric predictors (wind components and speed, temperature, and geopotential height) from the reanalysis products to predict historical wind observations at weather surface stations in Canada. Empirical orthogonal functions (EOF) of the predictor fields are calculated, and predictor sets are created from a principal component analysis of the combined EOF time-series. The model's performance is assessed as a function of season, geographic location, and averaging timescale of the wind statistics. The solstitial seasons are found to be better predicted than the equinoctal seasons, with the winter and summer having comparable prediction skill. Large differences in prediction skill are seen between neighboring locations, and no clear relation between geographic location and model performance is observed. A clear pattern of predictive skill is seen with respect to the time averaging period. The prediction skill decreases as the time averaging period increases; this is true across all predictands (mean and variance). Consistent with recent studies of the predictability of sea surface winds, vector wind components are better predicted than wind speeds. These results are interpreted with the aid of an idealized model of the wind speed probability density function.

3P407.1 ID:5032 15:30

Exotic visitors and warming events: west coast Vancouver Island

Moira Galbraith
DFO-Institute of Ocean Sciences
Contact: galbraithm@pac.dfo-mpo.gc.ca

Intensive sampling along the west coast of Vancouver Island, seasonally, unbroken over a long time span has afforded us the luxury of being able to identify the community structure of zooplankton on the shelf, shelf break and near shore coastal areas and to recognize visitors from other regimes: oceanic, subtropical or subarctic. Oceanic events: Pacific Decadal Oscillation and El Niño's/La Niña

compounded on Alaska Gyre, Davidson Current, etc.; carry their own compliment of species characteristic to that particular water mass. Information on variations in ocean conditions (warm versus cold) along the west coast Vancouver Island shelf can be gleaned from knowing what species of zooplankton is in the area and will identify the short versus long term visitors.

1C0.2 ID:5033 14:30

The Border Air Quality and Meteorology Study (BAQS-Met): Overview, Comparisons between Observations and Models, and Lessons Learned

Paul Makar [1], *Jeff Brook* [1], *David Sills* [2], *Katherine Hayden* [1], *Craig Stroud* [1], *Michael Moran* [1], *Junhua Zhang* [1], *Wanmin Gong* [1], *Sunling Gong* [1], *Cris Mihele* [1], *Qian Li* [1], *Didier Davignon* [3]
[1] Air Quality Research Division, Environment Canada
[2] National Laboratory for Nowcasting and Remote Sensing Meteorology, Environment Canada
[3] Air Quality Model Applications Section, Environment Canada
Contact: paul.makar@ec.gc.ca

The Border Air Quality and Meteorology Study (BAQS-Met) took place during the summer of 2007 in the Windsor-Detroit area. Mesonet monitoring of meteorology, ozone and particulate matter from June through August was complemented by a measurement intensive involving the National Research Council of Canada Twin Otter aircraft, the CRUISER mobile laboratory, and three surface measurement “supersites”. In-field forecasts using A Unified Regional Air-quality Modelling System (AURAMS) driven by a15km version of the Global Environmental Multiscale (GEM) meteorological model were used to guide the deployment of the aircraft and mobile laboratory.

Subsequent to the field study, a three-level nested version of AURAMS was constructed in order to determine the degree of supporting evidence for the study’s main hypotheses: 1. that the relative importance of local emissions is enhanced due to the presence of the Great Lakes, 2. that accurate diagnosis and modelling of lake breeze circulations will lead to improved understanding and forecasting of air-quality and thunderstorms in the region, and 3. that the accuracy of air-quality forecasting in southern Ontario is significantly impacted by how the model and data assimilation system are treating the processes over the Great Lakes.

The observations and simulations show evidence that the local lake-breeze circulation has a very significant impact on regional ozone and particulate matter formation. The main features: lake breeze-induced convergence lines which collect precursors and enhance smog formation; recirculation and “cooking” of aged pollutants in lake-breezes, intense photochemical activity at the lake surfaces; and fumigation of highly polluted air in recirculation events. Model resolution was shown to have a significant impact on capturing these features. The breadth and depth of the observational dataset led to several key improvements in the AURAMS modelling system (e.g. a new dynamic ozone boundary condition, better representation of secondary organic aerosol formation).

4D4.5 ID:5034 16:30

RADARSAT-2 Mode Selection for Maritime Surveillance

Matt Arkett
Canadian Ice Service - MSC - EC
Contact: matt.arkett@ec.gc.ca

Roger De Abreu (1), Paris Vachon (2), John Wolfe (2), Matt Arkett (1), Angela Cheng (1), Tom Zagon (1), and Derek Mueller (1)

(1) Canadian Ice Service, Environment Canada, Ottawa, Ontario, Canada

(2) Defence Research & Development Canada – Ottawa, Department of National Defence, Ottawa, Ontario, Canada

The Canadian Ice Service (CIS) promotes safe and efficient maritime operations and protects Canada's environment by providing reliable and timely information about ice and iceberg conditions in Canadian waters. The CIS relies on a suite of both airborne and satellite sensors to operationally monitor ice conditions in Canadian coastal and inland waterways. Defence Research & Development Canada – Ottawa (DRDC-O) is the lead authority and center of expertise in the Defence R&D Canada Agency for the exploitation of the electromagnetic spectrum to meet future Canadian Forces, Departmental and National needs.

RADARSAT-2, the follow-on mission to RADARSAT-1, offers maritime users a wider variety of ScanSAR modes for routine surveillance of Canadian coastal waters. This increase in available beam modes has also led to an increase in the types of application within the marine community. Improving the utilization of RADARSAT-2 for maritime stakeholder departments would help to reduce costs and improve the accuracy of operational products.

The results of this collaborative research between the CIS and DRDC-O identifies preferred and secondary ScanSAR-based Maritime Surveillance Modes for RADARSAT-2 that would usefully serve seven maritime applications – ship detection, ice surveillance, iceberg detection, ice island detection, oil detection, ocean feature detection and wind field retrieval. Through the characterization of the performance of these beam modes, we identify those that can serve multiple marine applications. These recommendations attempt to streamline the image acquisition planning for coastal environments and allows for the useful sharing of imagery among stakeholder departments.

2B2.3 ID:5035 11:00

Achieving known and identified quality for all Meteorological Service of Canada data by enhancing quality assessment within a new Data Quality Management System

Dale Boudreau , *Hannah Fong*
(Presented by *Tony Colavecchia*)
Environment Canada - MSC
Contact: dale.boudreau@ec.gc.ca

The Meteorological Service of Canada has a data management initiative which is in the process of renewing and improving the way meteorological data are managed from existing Environment Canada networks as well as 3rd party contributions from current and future partnerships. The resulting data management framework (DMF) and its infrastructure will support a data quality management system (DQMS) for operational data processed by, and contained within, the new data management system. This will be accomplished by implementing, facilitating, and/or being consistent with, quality assurance activities and highly automated quality assessment/control procedures, which together allow the quality of all data to be known at all times and ensures established quality standards are met or exceeded. The first phase of the DQMS' implementation will be to put in place a quality assessment (Qa) framework which will mainly be composed of applications performing automatic Qa on data as close to source and as soon as possible. In this way, more downstream clients, processes and products will benefit. The new system will contain many enhancements in the way Qa is performed. It will be extremely flexible, dynamic, extensible and powerful in the way Qa tests are input, managed, and executed. Key features of this system over current systems will be element-level flagging for all networks, known quality at all stages of the data flow, a consistent, extensible and comprehensive flagging scheme applied to all data in the DMS, and a data history so raw data as well as subsequent assessments (i.e. flags) and corrections are retained. This presentation will outline the Qa framework being implemented, key functionality, and the basic outputs and metadata which support subsequent quality control, corrective actions and quality improvements, which are other key requirements of the over-all DQMS.

2C3.5 ID:5036 15:00

Longwave radiation observations, modeling and reconstruction in the winter High Arctic.

Colin Pike-Thackray , *Glen Lesins* , *Christopher Perro* , *Jon Doyle* , *Graeme Nott* , *Jason Hopper* , *Tom Duck*
Dalhousie University
Contact: colin.pike-thackray@dal.ca

During the arctic winter, downward longwave radiation is the largest positive contributor to the surface energy budget, making its characterization important to understanding the High Arctic climate. Measurements of the downward radiation are a recent development at Eureka, located at 80N latitude on Ellesmere Island, providing an opportunity to test radiative transfer models, to attribute the sources of the downward radiative forcing and to evaluate various remote sensing techniques applied to the rest of the Arctic.

The radiative transfer model SBDART is used to compute the longwave radiation. First, its effectiveness is evaluated against measurements of downward longwave radiation at Eureka, using lidar-retrieved water-vapour and cloud profile information, as well as radiosonde temperatures as input. Next, the decomposition of the total longwave into contributions from sources (water vapour, temperature, and cloud profiles) is performed using the model, and the relative effects of each are investigated.

Finally, a method of diagnosing cloud altitudes, vertical thicknesses and optical depths from radiosondes is introduced, which - with SBDART - allows the construction of the winter downward longwave radiation at the surface at Eureka going back more than 30 years. This historical longwave radiative forcing is needed to help our understanding of the Arctic Amplification of surface temperatures related to global warming.

3P407.2 ID:5037 15:30

Changing seasonal timing of marine zooplankton populations, and their link to ocean climate

David Mackas
Fisheries and Oceans Canada
Contact: Dave.Mackas@dfo-mpo.gc.ca

The short life span (weeks to a year) of most zooplankton allows their population size to respond rapidly to interannual environmental changes, and also leads to large seasonal cycles producing 3-10 fold (or more) variation of abundance, biomass, species composition, and age structure within species. Although the zooplankton seasonal response is somewhat periodic, recent analyses have found that the detailed phasing is highly sensitive to interannual differences in environmental conditions: there can be year-to-year differences of one to several months in the timing of a 1-2-month wide annual peak of abundance and biomass. The resulting potential for timing match-mismatch between prey and predators makes this an important and interesting signal, which can be tracked by either population size or age-stage structure. Within species, the usual trend is a shift to earlier development in years when temperatures are higher and stratification stronger. However, temperature-timing regressions frequently differ among species and functional groups, leading to different amounts of timing offset for a given temperature perturbation. Climate warming can also drive changes in community composition that favor summer-dominant over spring-dominant taxa

2C0.1 ID:5038 14:00

Operational Oceanography – A Renewed Focus within Fisheries and Oceans Canada

Helen Joseph
Fisheries and Oceans Canada
Contact: Helen.Joseph@dfo-mpo.gc.ca

Operational oceanography can be defined as "the application of science to provide timely, accurate and value-added oceanographic products and services that inform decision-makers". Current events are highlighting the importance of operational oceanography within Fisheries and Oceans Canada (DFO) and the Department is moving forward with a proactive stance in this area for the future. DFO's renewed efforts and focus on operational oceanography will continue to reflect a broad spectrum of clients. These decision-maker clients include, among others, the Canadian Coast Guard, fishery managers and coastal communities. In developing operational oceanography capability and applications, DFO works closely with other government departments through the tri-departmental (DFO, Environment Canada, and National Defence) initiative entitled Canadian Operational Network of Coupled Environmental PredicTion Systems (CONCEPTS). Close collaborations with academic partners are also key in developing operational oceanography capability and successful applications. This presentation will outline the developing DFO national strategy for operational oceanography, as well as highlight efforts from several client-driven applications.

3B1.2 ID:5039 10:45

A Major Upgrade to the Canadian Global Deterministic Forecast System

Sylvain Heilliette , *Godelieve Deblonde* , *Mark Buehner* , *Louis Garand* , *Alain Beaulne* , *Bruce Brasnett* , *Stephen Macpherson* , *Real Sarrazin*
Environnement Canada
Contact: sylvain.heilliette@ec.gc.ca

The evaluation of a major upgrade to the Global Canadian Forecast system in parallel with the current operational system started in January 2011. It should replace the operational system near May 2011. This upgrade affects both the model and analysis components. In this presentation, emphasis is put on the data assimilation component. Both operational and upgraded systems use a version of the Global Environmental Multiscale (GEM) model with a 800x600 horizontal grid, 80 vertical hybrid levels and a top at 0.1 hPa. The 4DVar analysis is done on a 240x120 horizontal grid. In the upgraded system, the spatial density of all satellite observations assimilated was increased (the spatial thinning was decreased from 250 km to 150 km). New observations types were added to the system: cloud-unaffected infrared radiances (62 channels) from the European Infrared Atmospheric Sounding Interferometer (IASI) instrument flying onboard METOP, clear sky water vapor sensitive radiances from 3 geostationary satellites (METEOSAT-7, MSG-2 and MTSAT-1R), SSMI like channels from

the SSMI-S microwave imager (7 channels), and humidity measurements from aircrafts. A new sea surface temperature analysis was also introduced to improve the lower boundary conditions provided to the model and cloud detection above sea for the assimilation of infrared radiances. A significant positive impact on forecast was clearly demonstrated using validation against radiosondes and analysis. This positive impact was confirmed by the case by case evaluation of synoptic situations performed by operational meteorologists.

1C5.1 ID:5040 INVITED/INVITÉ 14:00

CanRCM4: A New Regional Climate Model for Downscaling Canada's CMIP5 Contribution

John Scinocca , *Mike Lazare* , *Slava Kharin* , *Yanjun Jaio* , *Minwei Qian* , *Greg Flato*
CCCma, University of Victoria, Victoria, BC
Contact: John.Scinocca@ec.gc.ca

Over the past five years, the Canadian Centre for Climate Modelling and Analysis (CCCma) and Recherche Prévision Numérique (RPN) have collaborated on the development of a new regional climate model CanRCM4. CanRCM4 combines the Semi-Lagrangian dynamical core of the RPN's weather forecast model, GEM, with the physics package from CCCma's forth generation atmospheric climate model CanAM4. As part of the WCRP CORDEX project, CanRCM4 will be used to downscale CCCma's global climate simulations which form Canada's contribution to the IPCC 5th assessment. Novel properties of CanRCM4 include an identical physics package shared between the global and regional climate models and a new procedure to derive sensible boundary conditions for model-specific tracer variables when driving the RCM with reanalysis data. Sample results from CanRCM4 driven by reanalysis data will be presented for three of the CORDEX domains: North America, Africa, and the Arctic.

3C6.1 ID:5042 13:30

Statistical adjustment of decadal predictions

Viatcheslav Kharin
CCCma, Environment Canada, Victoria, B.C.
Contact: slava.kharin@ec.gc.ca

The CMIP5 protocol for 'near-term' predictions prescribes producing ensembles of 10- to 30-yr hindcasts and forecasts initialized from climate states observed in years 1960, 1965, and so on until 2005 and beyond. The usage of decadal hindcasts is generally twofold: 1) to estimate systematic model biases and drifts, and 2) to evaluate predictive skill. These are two standard tasks in short-term climate forecasting, e.g., in seasonal forecasting. In this study we discuss additional challenges that may arise in decadal forecasting in a transient climate setting. It is argued that the estimation of model biases and drifts should account for possible differences in model sensitivity to external forcing as compared to the observed system. The findings are illustrated on decadal hindcasts of global mean temperature produced with a global climate model of the Canadian Centre for Climate Modelling and Analysis.

3B0.4 ID:5043 11:45

The Influence of a Well-Resolved Stratosphere on Seasonal Prediction

John Scinocca [1], *Michael Sigmond* [2], *Slava Kharin* [1]
[1] CCCma, University of Victoria, Victoria, BC
[2] University of Toronto, Toronto, ON
Contact: John.Scinocca@ec.gc.ca

In this study, the influence of the stratosphere on seasonal forecast skill is investigated by the careful analysis of two-tier hindcasts employing companion high-top and low-top models. The simulations are performed with the Canadian Middle Atmosphere Model (CMAM) in support of the Stratospheric Historical Forecast Project as part of the WCRP CLIVAR Working Group on Seasonal to Interannual Prediction. It is anticipated that the high-top models should provide improved hindcast skill due to improved dynamics and circulations. However, such improvement is also sensitive to the manner of initialization and this can be a complicating factor in the analysis. To eliminate the influence of initialization, we investigate the predictability of seasonal forecasts in the high-top and low-top models through a series of AMIP-type integrations where information is provided by sea-surface temperatures and sea-ice alone. This provides a measure of the potential predictability in the hindcasts and allows a clearer indication of the influence of the stratosphere in enhancing seasonal predictability.

4B0.1 ID:5044 10:30

Use of uniform CO2 concentration biases terrestrial carbon uptake in carbon-climate model simulations

Charles Curry
Canadian Centre for Climate Modelling and Analysis (CCCma)
Contact: charles.curry@ec.gc.ca

The effect of employing spatially and temporally uniform atmospheric carbon dioxide concentration as opposed to freely varying (3D, time-evolving) CO2 is analyzed in a series of global, coupled carbon-climate simulations. The focus is on atmosphere-land CO2 exchange, which is shown to be positively biased in the uniform CO2 experiments. While freely varying CO2 is lowered by photosynthesizing vegetation in the summer hemisphere, no atmospheric response is possible in the fixed CO2 experiments, prompting anomalous uptake due to the higher local CO2 concentration. In the model used here (the CCCma CanESM1), the difference in equilibrium (control) land carbon stocks between the two types of simulation is about 18 PgC. Simulations of the 1850-2000 period, conducted with the same global average but time-varying CO2 concentration, show that runs with uniform concentration overestimate cumulative terrestrial carbon uptake in CanESM1 by 19-28 PgC (33-50%) compared to the experiments driven with historical CO2 emissions, with the spread reflecting differences in the chosen initial control state. Accounting for a small increase in ocean carbon uptake over the same period implies a corresponding bias in the diagnosed CO2 emissions from the specified concentration run of +33 to +38 PgC (11-13%).

Although comparable simulations with other carbon-climate models should be conducted, these results suggest that the bias introduced in uniform CO2 simulations will increase uncertainty in estimates of the historical land carbon sink and diagnosed carbon emissions.

4D4.4 ID:5046 16:15

Wind speed retrieval based on RADARSAT cross-polarization channels

Sergey Komarov [1], *Alexander Komarov* [2], *Vladimir Zabeline* [1]

[1] MSC
[2] Manitoba University
Contact: vladimir.zabeline@ec.gc.ca

The SAR Winds system for the routine retrieval of the surface wind speed over Canada's coastal waters is currently being implemented at EC MSC, Network Strategies and Design after a two-year pilot project. The quasi-operational system is processing RADARSAT-1, 2 as well as ENVISAT satellite images with very high resolutions. Initially only co-polarization images were utilized for the CMOD_IFR2 algorithm modified for HH channel by the Kirchhoff approximation. The system could not employ information from the RADARSAT-2 cross-polarization channels. We have demonstrated that the use of RADARSAT-2 cross-polarization channels could significantly improve the accuracy of SAR Winds speed retrieval system. A significant number of ocean buoy measurements coincided and collocated with SAR observations over the West and East Canadian Coasts were collected. The time difference between SAR images and buoy data did not exceed 30 min. We have built an array of marine wind speed retrieval models based on RADARSAT-2 ScanSAR Wide and ScanSAR Narrow dual polarization images. The models were intended to improve CMOD-model performance. We show that the developed regression models with co- and cross-polarizations independent variables perform better than the CMOD model. This result was verified on a large subset of independent data.
The project was supported by the Canadian Space Agency through the Government Related Initiative Program (GRIP).

2C5.5 ID:5047 15:15

Variation in the concentration of redox sensitive dissolved metals in response to a bottom water renewal event in Saanich Inlet, BC

Jay Cullen [1], *Frank Whitney* [2], *Sharon Blackmore* [1]
[1] University of Victoria, School of Earth and Ocean Sciences, Victoria BC, Canada
[2] Department of Fisheries and Oceans, IOS, Sidney BC, Canada
Contact: jcullen@uvic.ca

Saanich Inlet is a temperate fjord (maximum depth 225 m) characterized by weak estuarine circulation and weak mixing within the water column. The presence of a 70 m deep sill isolates basin waters of the Inlet, and high rates of primary production and export of organic matter results in anoxia for much of the year below approximately 150 m depth. Periodically, density driven inflows reoxygenate the basin. These renewal waters are upwelled off the west coast of Vancouver Island and are transported through the Juan de Fuca Strait. Strong tidal mixing in the Strait normally acts to reduce the density of upwelled waters and prevent their incursion over the sill. However, when summer tides are weakest, waters of sufficient density reach the sill of the Inlet and renew basin waters on successive flood tides. Past estimates suggest that half of the water below 150 m is typically exchanged during these inflow events. Here we combine hydrographic observations from the Victoria Experimental Network Under the Sea (VENUS) with ship based physical and chemical measurements to examine variability in dissolved trace metal (Cu and Fe^{2+}) distributions in relation to basin physical processes. Observations at the VENUS array (97 m) indicate that seasonal incursions of oxygenated waters over the sill of Saanich Inlet occur in a stepwise fashion beginning in May 2006. These incursions cause waters at this depth to become warmer, saltier and cause 1-2 ml/L increases in dissolved oxygen concentrations. Dissolved Cu concentrations are higher in the oxygenated water column and near detection limit in the anoxic layer consistent with the formation of insoluble sulphides. Dissolved ferrous Fe concentrations are ~50-60 nmol/L at the beginning of 2006 and increase ~6-fold as the system restratifies and the basin accepts organic matter produced during the spring bloom.

4B2.4 ID:5048 11:15

Mainstreaming climate change information into water resources planning and management: The challenge of scenario selection and analysis

Robert Walker [1], *Linda Mortsch* [2], *Sam Bellamy* [3], *David Van Vliet* [3], *Mike Garraway* [4], *Lynne Millford* [4]
[1] EBNFLO Environmental
[2] Environment Canada
[3] Aqua Resource
[4] Ontario Ministry of Natural Resources
Contact: linda.mortsch@ec.gc.ca

Assessment of the hydrological effects of climate change for water resources planning and management is a challenging technical endeavour in an area of rapidly-expanding knowledge. A "Guide for Assessment of Hydrologic Effects of Climate Change in Ontario" was developed to assist practitioners in planning, setting up and conducting hydrologic and climate change impact assessments in the context of Drinking Water Source Protection and other commonly conducted water resource studies in Ontario. This presentation explores the key issue of determining the type and number of climate change scenarios to use in a modelling assessment and the implications for decision making with imperfect information and under uncertainty. In the Guide, scenarios were developed using Global Climate Model (GCM) output and downscaling techniques. Screening methods were used to select subsets of GCM output that includes: a 4-scenario "bound the uncertainty" subset, a 10-member "percentiles" group as well as a full ensemble of GCM outputs (i.e., 57 GCM runs). These scenarios were run in a "hypothetical watershed" formulation of a hydrologic model (Hydrologic Simulation Program – Fortran (HSPF)) in order to explore the implications of scenario screening and subset selection. As a trial of the approach, ten GCM scenarios selected by the percentiles approach as well as a number of downscaling scenarios were used in a case study of sub-watershed 19 in the Credit River watershed in Southern Ontario. Using an adaptation decision making perspective, the analysis approaches and results from the assessment are presented as well as the database and tools developed for climate scenario selection for climate stations across the Province.

4D3.1 ID:5049 15:30

The Lake Ontario Land Breeze Snow Band

Bryan Tugwood
Environment Canada
Contact: bryan.tugwood@ec.gc.ca

Lake-effect snow is a mainstay of winter weather in the Great Lakes from November through until March. While a majority of lake effect snow events take the form of wind-driven snow bands or squalls, a small percentage occur in synoptic patterns characterized with light winds and enhanced land breezes. These events, while not frequent, can have tremendous impacts when they affect heavily-populated areas which do not typically receive significant lake effect snow. For example, each winter the "Golden Horseshoe", which wraps around the Western end of Lake Ontario from Toronto to Niagara, can experience several land breeze snow band events, often with surprising snowfall accumulations. Given their narrow width and shallow depth, these meso-beta features are not well resolved by most forecast models, including higher resolution meso-scale models. Furthermore, their slow movement, irregular shape and poor detection on radar make them a unique forecasting challenge.

The winter of 2010-2011 yielded 3 noteworthy snow band events which affected the greater Toronto area. This presentation will examine each of the events in detail, while highlighting some subtle, yet

important, differences between them. A fourth weak snow band may also be briefly considered as an example of a null case, highlighting potential forecast thresholds for these snow bands. Finally, forecast suggestions will be presented to act as some guidelines to improve their predictability.

3B3.4 ID:5051 11:15

Kinetics of superoxide decay in eastern subarctic Pacific waters

Christina Schallenberg , *Jay Cullen*
University of Victoria, School of Earth and Ocean Sciences, Victoria BC, Canada
Contact: jcullen@uvic.ca

The cycling of reactive oxygen species (ROS) such as superoxide (O2-) in the upper ocean may provide information relevant to our understanding of biogeochemical rate processes. In the surface ocean, O2- can be generated abiotically by photochemical processes, or by microbes during biologically mediated cell surface reduction-oxidation reactions. Major sinks for O2- in seawater include redox reactions with biologically important metals, principally iron (Fe) and copper (Cu), as well as with dissolved organic matter (DOM). Here we present results of shipboard kinetic experiments designed to examine the fate of O2- in surface waters of the subarctic northeast Pacific. The observed decay kinetics, which are influenced by the chemical speciation of Cu and Fe in the seawater, and the concentration and nature of DOM promise to shed new light on the importance of O2- in controlling the bioavailability of trace nutrients that can control carbon and nitrogen biogeochemistry and the fate of DOM in the marine environment.

4B4.2 ID:5054 11:00

Using the All-Source Green’s Function for Fast Responses in Storm Surges

Zhigang Xu , *Michel Beaulieu* , *Denis Lefaivre*
Modeling and Operational and Oceanography Division, CHS, IML Fisheries and Oceans Canada
Contact: Zhigang.Xu@dfo-mpo.gc.ca

Recently Xu (2007, 2011) proposed a new type of Green’s function to the linear shallow water dynamic system, the all-source Green’s function (ASGF), and demonstrated its power in instantaneously producing the water level responses at one or several points of interest to a tsunami triggered anywhere in the world oceans. Storm surges and tsunami waves obey the same linear dynamics, therefore the ASGF may well be applied to storm surge problems, benefiting, among others, a fast calculation of water level responses to arbitrary atmospheric forcing.

Unlike the impulsive external forcing in a tsunami problem, the external forcing in a storm surge problem is long lasting and evolves with time. Consequently, the ASGF has to be multiplied with the forcing in a time-convolution manner. A time convolution is computationally expensive, however there are some potentials that we can explore to economize the convolution. The potentials lie in the facts of 1) the time interval between two successive forcing fields are on an order of minutes or even of hours, which is much larger than the time step used in a surge model, which is typically on an order of seconds; 2) the spatial resolution in the forcing field is much coarser than the one in the response field; 3) as the kernel of the convolution, the ASGF has its memory scale; any forcing older than the memory scale can be effectively neglected. In this presentation, we will explore these potentials to speed up the convolution calculations. The ultimate goal of this endeavor is to have a transfer function to efficiently transfer the atmospheric forcing fields to water level time series at a point of interest,

which can be a very desirable tool in addressing water levels responses to decadal or longer climatologic forcing.

4C1.4 ID:5055 14:45

Validation of CRCM5 simulations over Africa

Katja Winger [1], *René Laprise* [1], *Bernard Dugas* [2], *Laxmi Sushama* [1], *Leticia Hernandez-Diaz* [1]
[1] UQAM
[2] Environment Canada
Contact: Katja.Winger@ec.gc.ca

CRCM5, the new generation of the Canadian RCM, is based on the existing GEM (Global Environmental Multiscale) model that is presently used for global and regional weather prediction at the Meteorological Service of Canada (MSC). This paper will present validation of CRCM5 simulated mean annual and seasonal climatologies over Africa by comparing the ERA-Interim driven CRCM simulations for the 1989–2008 period at two different model resolutions (i.e., 0.44o and 0.22o) with observations. The study will also focus on the dynamics of the African Easterly Jet (AEJ), and assess the ability of the model in capturing both intensity and location of the jet for the two model resolutions. Previous model studies such as Cook (1999) have shown that realistic surface wetness contrasts between the Sahara and equatorial Africa, which leads to strong positive meridional temperature gradients at the surface and in the lower troposphere, is essential to generate strong enough easterly shear in the atmosphere to establish the AEJ above the monsoon westerlies at the surface, and that positive temperature gradients associated with the summertime distributions of solar radiation, SSTs, or clouds are not large enough to produce the easterly jet in the absence of soil moisture gradients. This paper thus will also show some preliminary results from sensitivity experiments performed to study the impact of soil moisture regime on AEJ.

3P206.2 ID:5056 15:30

Stratified verification of objective forecasts of ceiling and visibility

Bjarne Hansen , *Alister Ling*
Environment Canada
Contact: bjarne.hansen@ec.gc.ca

Stratified verification (SV) is verification with sets of matched forecasts and observations stratified based on conditions in the sets. SV is sometimes referred to as conditional verification or regime-based verification. SV is useful for obtaining extra insight into complex relationships between variables (predictors and predictands) such as cloud ceiling, visibility, time, precipitation, and wind direction and speed.

The work described here applies SV to verify objective categorical forecasts of cloud ceiling and visibility at specific airports. Types of questions addressed include: a) Stratification with respect to time: at projection period time plus x hours (T+X), how does forecast ceiling category Y verify when forecast ceiling category is Y; b) Stratification w.r.t. initial conditions: at projection period T+X, how does forecast ceiling category Y verify when observed category is Y at time-zero (referred to as conditional persistence); c) Stratification w.r.t. independent variables: how does forecast ceiling category Y verify when forecast category of wind direction is Z (referred to as regime-based verification).

To facilitate interpretation of results, this work combines statistical analysis with visual analysis. Classic scores are used for verification; however, the use of stratification is semi-original. An inherent problem with stratification is that as the number of stratifications increases, the volume of resulting charts and tables data increases, which makes it increasingly difficult to interpret results, and to find significant information “hidden in the data.” In addition, too much stratification can lead to empty bins and small sample statistical issues. However, some forecasters insist that it is better to be warned of a small sample and accept lower confidence in noisy statistics, than to have robust statistics on cases that are largely irrelevant to the situation at hand. Novel types of graphical analyses are developed to improve visualization of data and thus help to interpret results.

Supplementary website: http://collaboration.cmc.ec.gc.ca/science/arma/cmos

3C2.5 ID:5058 14:45

Projecting future glacier mass balance in the Coast Mountains of western Canada using distributed glacier mass balance model

Raju Aryal , *Bruce Ainslie* , *Peter Jackson*
University of Northern British Columbia
Contact: aryal@unbc.ca

A glacier mass balance model (GMB) has been developed for the southern Coast Mountains of British Columbia, Canada. The model is fully distributed and based on an energy balance approach. The GMB model has been tested at Place glacier over the period of 1980 to 2008 using climate fields obtained from a 30 year 8 km resolution meso-scale RAMS model simulation. The model has also been tested at a other glaciers in the region. Additionally, the model was run at selected glaciers in the southern Coast Mountains for future climate scenarios (A2 SERES emission scenario) from CGCM3.1, a third generation GCM from Canadian Centre for Climate Modelling and Analysis (CCCma). Modelled historical and future glacier mass balance results will be presented. This information can be useful for formulating future water management policies and adaptation strategies to cope with challenges associated with climate change and glacier recession.

4D0.2 ID:5060 15:45

Are estimates of past carbon cycle - climate feedbacks useful indicators of future feedbacks?

Michael Eby [1], *Andrew Weaver* [1], *Nathan Gillett* [2], *Kirsten Zickfeld* [3]
[1] University of Victoria
[2] Environment Canada
[3] Simon Fraser University
Contact: eby@uvic.ca

Global climate model projections of future climate play an important role in informing national and international environmental policy discussions. Given the potential cost of action or inaction to climate change, it is imperative that model uncertainties be reduced to the extent possible. An important source of model uncertainty lies in the strength of the carbon cycle - climate feedback. A recent comprehensive study has indicated that this feedback is moderate with limited time-scale dependence providing reduced possibilities for unwelcome surprises within the next century. We suggest that this study is underestimating the feedback. We further show that the strength of the total carbon cycle - climate feedback strongly depends on the background state of the climate system and increases with increasing atmospheric CO2 concentrations. This implies that feedback estimates obtained using late Holocene paleoclimate data may give a poor indication of future feedbacks.

1C6.2 ID:5061 14:15

Streamflow patterns of northwest Canadian permafrost areas and their links with large scale climate variability

M. Naveed Khaliq
Environment Canada
Contact: naveed.khaliq@ec.gc.ca

In this presentation, characteristics of hydrological response, seasonality of annual low and high flow and temporal changes in average winter (January to March) flow (as representative of low flow conditions) and spring/summer high flow for continuous, discontinuous and sporadic permafrost zones of northwest Canada will be discussed. Results of an investigation of the influence of Pacific Decadal Oscillation on local scale winter flow patterns across northwestern North America, as well as a robust framework for analysis of temporal trends will also be presented. The results of the study have strong implications for design and operation of infrastructure facilities in this climate-sensitive region.

3C5.4 ID:5063 14:15

Impact of drought-induced tree mortality on the carbon balance of a mature aspen forest

Alan Barr [1], *Andy Black* [2], *Ted Hogg* [3], *Nick Grant* [2], *Zoran Nesic* [2]
[1] Climate Research Division, Environment Canada
[2] U.B.C.
[3] Canadian Forest Service
Contact: alan.barr@ec.gc.ca

A severe drought occurred in most of western Canada and the USA in 2001 to 2003. The drought resulted in significant die-back of aspen forests in western Canada. The drought was preceded by several years of near-normal precipitation and followed by several years of higher than normal precipitation. This study will report measurements from an eddy-covariance flux tower in a mature aspen stand in the southern boreal forests of central Saskatchewan. The Old Aspen site was operated as part of the Boreal Ecosystem Research and Monitoring Sites and the Canadian Carbon Program.

The 2001-2003 drought caused a delayed but sustained increase in the annual rate of tree mortality at the Old Aspen site. This study will analyze the carbon balance of the stand before, during and after the drought, and investigate the impact of the post-drought increase in tree mortality on net ecosystem production and its partitioning between gross ecosystem photosynthesis and ecosystem respiration.

3B1.1 ID:5065 10:30

An update from CMC Operations

Nicole Bois
Environment Canada
Contact: nicole.bois@ec.gc.ca

The Canadian Meteorological Center (CMC) runs, in a fully operational production environment, models and data assimilation systems that have been developed by its Development Division along with EC's Atmospheric Research groups and MSC National Labs. The current status of the operational forecasting suite will be reviewed.

In the past year - major meteorological innovations introduced into operational production were:

- Addition of an operational Gulf of St Lawrence coupled model; - Significant additions of remote sensing data in the assimilation system; - Replacement of the regional GEM (variable resolution grid) with a GEM-LAM model; - Ongoing REPS (regional ensemble prediction system) over Haiti to assist forecasting during the hurricane season; - Implementation of Strato2b (glb, reg, GEPS); - Implementation of CaPA precipitation analysis; - Implementation of an update to the SCRIBE nowcasting system; - Improvements to the experimental HRDPS (high resolution deterministic prediction system) i.e. LAM 2.5 km model to incorporate LAM Olympic innovations; - Availability of NWP data in GRIB2 format and assistance to users into converting from grib1 to grib2; - Availability of NAEFS (ensemble) data in GRIB2 and in xml formats on EC's data server;

In the coming year (June 2011-2012) - Improvements currently planned to the operational system are:

- Planning to implement multiseason coupled system; - Update to WAM 4.5.1; - Further planned changes or additions to the operational production suite will also be discussed.

3B2.4 ID:5066 11:30

Closing the hydrologic cycle for climate simulations using a simple yet rigorous approximation of Richard's Equation applied to the soil-water balance

Ric Soulis , *Guoxiang Liu* , *James Craig*
Civil and Environmental Engineering, University of Waterloo
Contact: rsoulis@uwaterloo.ca

Sub-grid lateral flow is among the most poorly parameterized processes in hydrologic modelling. The physics are well represented by the Richard's Equation, which is essentially the mass and momentum balance for flow through a soil matrix. Modellers usually abandon the daunting task of solving Richard's Equation and resort to empirical relationships that at best produce satisfactory runoff estimates. However, other surface processes that are particularly important in atmospheric modelling also require the distribution of retained soil moisture at the surface. A new approach, inspired by the atmospheric modelling program, is proposed for the near-surface water balance based on an approximate but very accurate 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. For a wide variety of soils, bulk saturations and internal water balance are within a quarter percent. Furthermore, the resulting recession curves are well approximated by power law of the forms usually used traditionally. This vindicates the use of the traditional empirical relationship: Q = Q0•[(S-SR)/(SC-SG)]b. However, the coefficients can be defined a priori from soil and topographic information. The impact of the approach on simulated hydrographs is demonstrated. The long term soil moisture estimates are compared with conventional field capacity values.

4C0.3 ID:5067 14:00

An important impact of Southern Hemisphere surface winds on global ocean carbon uptake and storage

Neil Swart [1], *John Fyfe* [2]
[1] University of Victoria
[2] Canadian Centre for Climate Modelling and Analysis
Contact: ncswart@uvic.ca

Forcing the UVic Earth System Climate Model with surface winds from each of the global climate models participating in the IPCC CMIP3 inter-comparison exercise highlights an important link between the latitudinal position of Southern Hemisphere winds and the global distribution of ocean carbon. It is well known that Southern Hemisphere surface winds from global climate models are systematically too equatorward relative to observations. We show, for the first time, that this wind-bias produces an underestimate of the Indian to Atlantic Ocean salt flux associated with the Agulhas Leakage, which in turn impacts the global distribution of ocean carbon through a connection to Labrador convection and North Atlantic overturning. Ekman pumping anomalies in the Southern Ocean also lead to a net reduction in total equilibrium ocean carbon storage in models with equatorward biased winds. These differences in modeled equilibrium ocean carbon storage lead to significant changes in ocean carbon uptake in transient climate simulations to the year 2300. Our results are of practical importance to global climate modellers, and could also help with the interpretation of paleo-wind shifts relative to the global carbon cycle.

1B1.1 ID:5068 INVITED/INVITÉ 11:00

Science and Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10) – Overview of results to date

George Isaac
(Presented by *G.a. Isaac*)
Cloud Physics and Severe Weather Research Section, Environment Canada
Contact: george.isaac@ec.gc.ca

George A. Isaac1, Paul Joe1, Jocelyn Mailhot2, Monika Bailey1, Stephane Bélair2, Faisal Boudala1, Melinda M. Brugman3, Edwin Campos4, Richard Carpenter5, Stewart G. Cober1, Bertrand Denis3, Chris Doyle3, I. Gultepe1, Thomas Haiden6, Laura Huang1, Jason Milbrandt2, Ruping Mo3, Roy Rasmussen7, H. Reaves8, Trevor Smith3, Ron Stewart 9, and Donghai Wang10

1 Cloud Physics and Severe Weather Research Section, Environment Canada, 2 Recherche en prévision numérique, Environment Canada, 3 Meteorological Service of Canada, Environment Canada, 4 Argonne National Laboratory, Illinois, USA, 5 Weather Decision Technologies, Oklahoma, USA, 6 Central Institute for Meteorology and Geodynamics (ZAMG), Austria, 7 National Center for Atmospheric Research, Colorado, USA, 8 National Severe Storms Laboratory, Norman, Oklahoma, USA, 9 Department of Environment and Geography, University of Manitoba, 10 Chinese Academy of Meteorological Science, China

The field phase of a new World Weather Research Programme (WWRP) project 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 the first similar project focused on 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 is being done 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. Some important conclusions have been obtained from the analysis of SNOW-V10 data. This paper will provide overall background information on the project and a short summary of some of the results produced to date.

3C4.5 ID:5069 14:45

Seasonal and interannual sea level variations in the Northeast Pacific

Tsuyoshi Wakamatsu , *Michael Foreman*
Institute of Ocean Sciences
Contact: tsuyoshi.wakamatsu@dfo-mpo.gc.ca

Basin scale sea level variation in the Northeast Pacific is mainly driven by passive responses to the local atmospheric forcing, i.e. heat flux and wind stress curl. In this study, sea level variation during the last decade is reconstructed from NCEP2 reanalysis forcing data using simple model and it shows generally good agreement with altimeter data. However, significant disagreement with altimeter data still remains in the seasonal cycle of reconstructed sea level variation. The seasonal and interannual sea level variations from high resolution hindcast model outputs are also compared with altimeter data and their dynamics will be discussed.

2B5.5 ID:5070 11:45

Nitrate isotope fractionation druing denitrification in Saanich Inlet: water column versus sediment effects

Annie Bourbonnais [1], *Moritz F. Lehmann* [2], *Roberta C. Hamme* [1], *Cara C. Manning* [1], *S. Kim Juniper* [1]
[1] University of Victoria, British Columbia, Canada
[2] Institute for Environmental Geoscience, Basel University, Switzerland
Contact: anniebourbonnais@yahoo.ca

It is still a matter of debate whether the global marine fixed nitrogen (N) budget is in balance or not, mainly because of the large uncertainties regarding N source (N_2 fixation) and N loss (denitrification) estimates. One of the main challenges in evaluating global N loss by denitrification in the modern ocean is quantifying the relative importance of sedimentary versus water-column denitrification in suboxic zones. We report here on a study in Saanich Inlet, an intermittently suboxic British Columbia fjord, where we examined the relationship between seasonal variations in benthic versus water column nitrate elimination, and the N and O isotope signatures of water column nitrate. Water and gas samples were collected between April 2008 and April 2009. We measured dissolved nutrients, the N and O isotope composition of nitrate, and N_2/Ar ratios at different depths through the water column at a station near the mouth of the inlet. Measured variables changed significantly throughout the year as a result of seasonal changes in surface water primary productivity, subsequent flux-controlled organic matter respiration, and the periodic development of anoxia in bottom waters. A gradual and equal increase in both the $\delta^{15}N$ and $\delta^{18}O$ of nitrate, associated with a decrease in nitrate concentrations and an increase in excess N_2, was observed after a major bottom-water re-oxygenation event in October 2008, suggesting nitrate consumption by denitrifiers in an expanding suboxic zone. Nitrate isotope effects were as low as 11.5‰ for both N and O isotopes, lower than the ~25-30‰ for water column denitrification reported in other studies. Assuming isotope effects of 1.5‰ and 25‰ for sedimentary and water-column denitrification, respectively, and considering both closed and open system models,

we estimate that at maximum 60% of the Saanich Inlet nitrate is lost through sedimentary denitrification.

3C0.5 ID:5071 14:45

An Objective Definition of the Tropopause

Andre Erler [1], *Robert Field* [2], *Dylan Jones* [1], *Theodore Shepherd* [1]
[1] University of Toronto
[2] NASA GISS, Columbia APAM
Contact: aerler@atmosp.physics.utoronto.ca

Current definitions of the tropopause are purely empirical, and in the case of the dynamical tropopause, there is not even consensus in the literature. At the same time, accurate identification of the tropopause is important for many applications ranging from estimation of dynamical stratosphere-troposphere exchange to the retrieval of atmospheric composition. Here we propose an objective way to identify the tropopause, based on the gradient of materially conserved quantities. Potential temperature is used to define an equivalent to the thermal tropopause, and PV is used to define a dynamical tropopause. We use high resolution ECMWF analysis data and idealized modeling experiments to demonstrate that this new method provides a better and more consistent characterization of the horizontal and vertical structure of the atmosphere than previous tropopause definitions. Furthermore we introduce a measure for tropopause sharpness and argue that in some regions the tropopause can not be defined in a meaningful way. The new dynamical and thermal tropopause definitions have a consistent horizontal structure and sharpness; major differences between them are limited to regions where the tropopause is not well defined, such as the centres of cyclonic vortices. We conclude with a summary of the seasonal and synoptic variability of the tropopause, and briefly discuss the implications for stratosphere-troposphere exchange and the fine-scale structure of the tropopause.

1B0.3 ID:5072 12:00

The use of image metric techniques to track changes in visibility

Andrew Teakles , *Keith Jones*
Environment Canada
Contact: andrew.teakles@ec.gc.ca

As part of a National Visibility Monitoring Pilot Study, Environment Canada's Air Quality Science Unit in Pacific and Yukon Region has been investigating strategies for monitoring visibility and the link to ambient air quality concentrations. The primary difficulty in monitoring visibility is that no one instrument can directly, objectively, and quantitatively measure visibility degradation as the human observer experiences it. Ideally, a host of instrumentation is needed to quantify various aspects of visibility. It is also common to supplement these quantitative instruments with camera systems to provide a visual record of the scenes and to facilitate public outreach efforts. The digital photographs captured by these camera systems can also provide a more direct means of measuring perceived visibility.

Currently, efforts are underway to develop objective metrics of visibility using image analysis techniques of digital photographs. In this study, the contrast measurements for various targets along a line-of-sight from Abbotsford, BC to Mt. Baker were compared to reconstructed estimates of light extinction for the 2009 summer season. The observed relationship between contrast extracted from

digital photographs and theoretical estimates will be discussed in relation to the impact of sun angle, sky condition, and image quality.

1P301.2 ID:5073 16:00

Resonant amplification of sub-inertial tides in a submarine canyon

Neil Swart [1], *Susan Allen* [2], *Blair Greenan* [3]
[1] University of Victoria
[2] University of British Columbia
[3] DFO, Bedford Institute of Oceanography
Contact: ncswart@uvic.ca

Tidal oscillations dominate the flow field in many submarine canyons. Observations have shown that semi-diurnal tidal energy in submarine canyons is significantly amplified with respect to adjacent shelves. This amplification is thought to be caused by focusing of propagating internal tides incident from the open ocean, or local in-canyon generation on critical canyon floor slopes. These mechanisms require freely propagating internal tides, with super-inertial frequencies. We present results from a moored array in a canyon at 44°N, where the observed velocities reached over 0.8 m/s. The canyon flow field was highly unusual because it was dominated by the sub-inertial diurnal tide. This occurred despite the fact that the barotropic tide was predominantly semi-diurnal. The diurnal tide was dramatically amplified in the canyon, its velocities increasing towards the seafloor, and canyon head. The diurnal oscillations also exhibited marked modulation in time by the background barotropic forcing. Length scales suggest that the diurnal tide should be resonant in the canyon. An analytical framework is used to explain the mechanisms behind the strong diurnal currents observed by the moored array. In the model, along-shelf barotropic flow sets up a double Kelvin wave response in the canyon, generating along-canyon velocities which are subsequently amplified by resonance. The pattern of the model predictions is in excellent agreement with the observed velocity pattern.

2B3.4 ID:5074 11:15

The XM Tool Prototype: A new statistical post-processing tool available in Canada to support of the Air Quality Health Index (AQHI) forecast program

Andrew Teakles , *Sean Perry*
Environment Canada
Contact: andrew.teakles@ec.gc.ca

The operational approaches for statistical post-processing used in Canada are largely based on linear statistical models (MLR and MDA) to reduce model bias and error. Recently, UMOS-AQ successfully applied these methods to the national air quality forecast program. However, a variety of statistical techniques have the potential to further enhance the operational air quality forecasting in Canada.

A new science initiative, the XM Tool Project, was launched by Environment Canada in the fall of 2009 to explore the use of non-linear statistical methods to extend the capabilities of UMOS and optimize the current AQHI forecast program with a particular focus on improved guidance for air quality episodes. Based on recent progress of the project, a prototype of the XM tool is planned for this summer and will provide hourly ozone, NO2, and PM2.5 forecasts via the AQHI web resources page.

The presentation will provide an overview of the XM Tool Project, give a summary of the current findings and a description of the summer prototype characteristics.

1P201.4 ID:5076 16:00

Volcanic perturbations to the stratospheric aerosol layer in the last decade

Adam Bourassa , *Landon Reiger* , *Doug Degenstein*
University of Saskatchewan
Contact: adam.bourassa@usask.ca

The Canadian built OSIRIS instrument, currently in operation on the Swedish Odin satellite, has collected over nine years of atmospheric limb radiance spectra at UV, visible and near infrared wavelengths. These measurements are used to retrieve vertical profi les of stratospheric aerosol extinction. The relatively high horizontal sampling of the limb scatter technique, which provides nearly global coverage, combined with the decade long duration of the mission, makes this an increasingly useful and important data set. This work shows validation of the OSIRIS aerosol retrievals with coincident SAGE III occultation measurements and demonstrates the e ffect of several relatively small volcanic eruptions on the state of the stratospheric aerosol layer.

2C5.3 ID:5077 14:45

IMPACT OF PERSISTENTLY LOW OXYGEN LEVELS IN BOTTOM-WATERS ON SEDIMENT CHEMISTRY: THE CASE OF THE LOWER ST. LAWRENCE ESTUARY

Stelly Lefort , *Alfonso Mucci* , *Bjorn Sundby*
(Presented by *Bjorn Sundby*)
Earth & Planetary Sciences, McGill University
Contact: bjorn.sundby@mcgill.ca

The number and areal extent of marine coastal environments with bottom-water oxygen levels lower than 62.5 μmol/L have increased dramatically throughout the ocean. Unlike the impacts of hypoxia on population dynamics and diversity of pelagic and benthic organisms, impacts on sediment chemistry remain poorly documented. We have compared the chemical composition of sediment and porewater in cores recovered in 1982 and 2007 at two sites the Lower St. Lawrence Estuary (LSLE). The bottom water at these sites has been persistently hypoxic for more than 25 years. The concentrations and the vertical distributions of total Fe and As in the cores have not changed since the 1980s, but the speciations of solid phase Fe and As have changed significantly. The relative amounts of Fe and As that can be extracted with 1M hydroxylamine hydrochloride in 25% acetic acid have increased while the degree of pyritization of Fe and As has decreased by respectively 50% and 75%. Furthermore, the concentrations of dissolved Fe and As in the sediment pore water have increased since 1982. We propose that in marine, iron-rich environments, such as the LSLE, low bottom-water oxygen concentrations interfere with pyritization, which would normally immobilize elements such as As by incorporating them into stable authigenic pyrite phases.

4C4.2 ID:5078 14:00

Use of satellite measurements to understand interannual variability of the Northeast Pacific Ocean.

Bill Crawford , *Nick Bolingbroke*
Inst. Ocean Sciences, Fisheries and Oceans Canada, Sidney, BC
Contact: bill.crawford@dfo-mpo.gc.ca

Much of the northeast Pacific Ocean is labeled high-nutrient (nitrate), low-chlorophyll (HNLC) based on years of sampling of ocean-surface nutrients and chlorophyll by research vessels. Year-to-year changes in the shape and extent of this region are difficult to track, since there are few wide-area, ship-based surveys over the region. It is now possible to track the different water masses based on ocean-surface chlorophyll measured from satellite and on changes in currents determined by satellite-altimetry and Argo profilers. Chlorophyll measurements indicate the concentration of phytoplankton at ocean surface, which in turn is an indicator of food available at the base of the food chain. We will combine these satellite measurements with ship-based sampling to reveal changes in the HNLC domain over the past decade, and how these changes are related to large-scale wind patterns and some coastal ecosystem changes.

4B2.3 ID:5079 11:00

Regional Climate Model results in Pacific North America and the northern Columbia Basin

Trevor Murdock
Pacific Climate Impacts Consortium
Contact: tmurdock@uvic.ca

Regional Climate Model (RCM) projections from the North American Regional Climate Change Assessment Program (NARCCAP) and from Ouranos Consortium have been analysed over Pacific North America. RCMs appear to reproduce general features of temperature and precipitation climatology over the region under large scale forcing at the boundaries by observations (NCEP2 reanalysis), including effects of complex topography on precipitation (windward and rainshadow areas) and of elevation on temperature. At the sub-regional scale, considerable differences exist between RCMs; these differences are compared to observations. The need to use as many ensemble members as possible for future projections is highlighted by showing the different between future projected changes for each RCM future simulation compared to its driving GCM and to regional downscaling (Bias Corrected Spatial Disaggregation). Finally, demand for projections of extremes has arisen out of local infrastructure vulnerability assessments and adaptation planning. A preliminary analysis of extremes is underway in collaboration with users (Columbia Basin Trust, Engineers Canada, and communities in the Columbia Basin), and the importance of using a large ensemble for projections of extremes is emphasized.

1A0.1 ID:5081 INVITED/INVITÉ 09:00

Uncertainty in climate change projections: the role of natural variability

Clara Deser
National Center for Atmospheric Research
Contact: cdeser@ucar.edu

Uncertainty in future climate change presents a key challenge for adaptation and mitigation planning. In this talk, I will discuss the role of natural climate variability as a major source of climate change uncertainty in middle and high latitudes. Results are based on a new 40-member ensemble of forced simulations for the period 2000-2060 with the National Center for Atmospheric Research Community Climate System Model Version 3 (CCSM3) under the SRES A1B greenhouse gas scenario. I will also address questions such as, what is the minimum ensemble size needed to detect the forced climate response and when does the forced climate response first becomes detectable? Finally, I will give an estimate of the relative contribution of natural variability to climate projection uncertainty in the CMIP3 multi-model archive.

4D5.1 ID:5082 INVITED/INVITÉ 15:30

Copepod legs — surface area vs. body size and potential swimming ability, a comparison of eight species

Susan Allen [1], *Alan Lewis* [1], *Catherine Johnson* [2]
[1] Earth and Ocean Sciences, University of British Columbia
[2] Bedford Institute of Oceanography, Fisheries and Oceans Canada
Contact: sallen@eos.ubc.ca

At the scale of a copepod, drag decreases as Reynolds number increases. For eight species of copepods, the thoracic leg surface area was measured. This allowed the propulsion from the legs to be estimated and compared to the drag of the body. A significant variation in the ratio between these two was found. The eight species of copepods included herbivores, omnivores, a carnivore, and a detritivore; they also provided a range of body length and volume as well as life styles. We will discuss the relationship between swimming ability (as measured by the ratio of leg propulsion to body drag) versus size and life styles.

4B0.5 ID:5083 11:30

Characterizing spatial representativeness of flux tower eddy-covariance measurements across the Canadian Carbon Program Network using remote sensing and footprint analysis

Baozhang Chen [1], *Nicholas Coops* [1], *Hank Margolis* [2], *Brian Amiro* [3], *Altaf Arain* [4], *Alan Barr* [5], *Andrew Black* [6], *Charles Bourque* [7], *Lawrence Flanagan* [8], *Peter Lafleur* [9], *Harry Mccaughey* [10], *Steven Wofsy* [11]
[1] Department of Forest Resource Management, University of British Columbia
[2] Faculté de Foresterie et de Géomatique, Université Laval
[3] Department of Soil Science, University of Manitoba
[4] School of Geography and Earth Sciences and McMaster Center For Climate Change, McMaster Universit
[5] Climate Research Branch, Meteorological Service of Canada
[6] Faculty of Land and Food Systems,University of British Columbia
[7] Faculty of Forestry and Environmental Management, University of New Brunswick
[8] Department of Biological Sciences, University of Lethbridge, Lethbridge
[9] Department of Geography, Trent University
[10] Department of Geography, Queen’s University
[11] Department of Earth and Planetary Science, Harvard University
Contact: baozhang.chen0808@gmail.com

We describe a pragmatic approach for evaluating the spatial representativeness of flux tower measurements based on footprint climatology modeling and analyses of detailed land cover classification and digital elevation model (DEM) maps and remotely sensed vegetation index signatures. The approach is applied to 12 Canadian Carbon Program (CCP) flux sites that include grassland, wetland, and temporal and boreal forests across an east-west continental gradient. The spatial variation within the footprint climatology area was evaluated by examining the spatial structure of vegetation index, land cover and topography using geostatistical measures, i.e. frequency distribution, variogram and window size analyses. The results show that (i) for at most CCP sites, the footprint area was comparatively flat (elevation varied within ~20 to m – ~50 m) with the topographic elements not influencing the wind flow and the variability of EC measured fluxesmeasurements; (ii) the percentages of the vegetation function cover type of interest (dominant land cover type) observed by the tower was higher than 40% for most CCP sites; (iii) most majority of sites presented somewhat anisotropic characteristics of Normalized Difference Vegetation Index (NDVI) in the 90% annual footprint climatology area; and (iv) the density of heterogeneity of flux footprint area was different among the sites. Overall, the forest sites had larger fine-scale spatial variation than the grassland and wetland sites. The coniferous boreal forest sites had higher coarse spatial variability than the two wetland sites and one a coniferous temperate forest site. We conclude that the combination of footprint modelling, semivariogram and window size techniques, together with remotely-sensed intermediate-resolution image data, is a pragmatic approach for assessing the spatial representativeness of flux tower measurements.

3P707.1 ID:5084 15:30

Tracing air mass sources applying a temperature-independent model to stable water isotopes in precipitation

Scott Jasechko [1], *Yi Yi* [2], *Carly Delavau* [3], *John Gibson* [2], *Jean Birks* [4]
[1] University of Waterloo; Alberta Innovates - Technology Futures
[2] Alberta Innovates - Technology Futures; University of Victoria
[3] University of Manitoba
[4] Alberta Innovates - Technology Futures; University of Waterloo
Contact: sjasechko@uwaterloo.ca

Physical climate data can be applied to map spatial and temporal variability in meteoric waters; however, physical measurements alone do not permit a direct quantification of the origin of moisture sources within the atmosphere. Combining physical and stable water isotope measurements has been shown to be an effective approach for constraining the history of moisture sources and has been applied in a variety of field studies and regional climate model simulations. Air mass origin, trajectories, and recycling of continental surface waters are expected to play a significant role in annual to decadal variations in climate patterns across Canada. To test this hypothesis, we examine monthly time-series records of stable isotopic composition of precipitation at stations across Canada and develop a new model that isolates and removes the temperature-dependent isotopic signal from seasonal temperature variability. Comparisons of our model output with observations from the Canadian Network for Isotopes in Precipitation are used to examine the influences of air mass origin, trajectory, and recycling of evaporated continental waters. Our results suggest that variations in the isotopic signatures of meteoric waters show potential to trace moisture sources across regional and continental scales.

3B2.2 ID:5085 11:00

Climate change impacts in the British Columbia watersheds: Comparison of GCM-downscaled and hydrologic model simulated outputs with RCM outputs

Rajesh Shrestha , *Anne Berland* , *Marcus Schnorbus* , *Arelia Werner*
Pacific Climate Impacts Consortium (PCIC)
Contact: rshresth@uvic.ca

The study analyzed potential climate-induced hydro-climatic change in the Peace and Upper Columbia watersheds in the British Columbia. Potential changes (between 2050s and1970s) in precipitation and temperature derived from two structurally different approaches: i) an ensemble of statistically downscaled general circulation models (GCMs) outputs from the Bias Correction Spatial Disaggregation (BCSD) approach, and ii) an ensemble of dynamically downscaled Canadian Regional Climate Model (CRCM) outputs were compared. In addition, runoff changes from the BCSD downscaled GCM-driven Variable Infiltration Capacity (VIC) hydrologic model outputs were compared with the CRCM outputs. Despite major structural differences between the two approaches, the results show that the projected precipitation and temperature from BCSD and the CRCM runs depict similar patterns of change (between 2050s and 1970s). Both approaches project general precipitation increases annually and in autumn, winter and spring, with lesser increase (Peace) and decrease (Upper Columbia) in summer. The two approaches also project similar temperature increases in 2050s, such as, greater increases in winter temperature in the Peace and greater increases in summer temperature in the Upper Columbia. Additionally, the GCM-BCSD driven VIC runoff simulations for the 2050s agree with the CRCM runoff in the direction and magnitude. The most significant changes include increases in total runoff, and earlier snowmelt and discharge peaks. Therefore, results present the stakeholders with the future climate projections based on the two structurally different approaches. The Peace and Upper Columbia basins are important resources to many in the province, and key areas

of hydropower generation. This study demonstrates that results obtained from different methods are in agreement, establishing that multiple approaches are arriving at the same result.

1C2.4 ID:5086 14:45

CARS-CAP Automated Weather Reporting

Peter Davies , *Kristin Virshbo*
Castle Rock Associates
Contact: abby@crc-corp.com

CARS (Condition Acquisition and Reporting System) is a suite of software modules, primarily used by state DOTS, facilitating the entry and sharing of traveler information data. Roadway “events” are entered manually into a core condition-reporting module and disseminated through various channels including 511 phone systems and websites. The system is also capable of importing data from external sources using TMDD-based XML messages. For years, Castle Rock struggled to find a way of using this capability to import real-time weather information, because there was no standards-based weather data feed available.

Recently, the National Weather Service (NWS) adopted XML standards for distributing weather alerts in a format known as CAP (Common Alerting Protocol). Castle Rock developed a new module called CARS-CAP, which allows a state’s CARS system to interface directly with the applicable CAP feed. NWS warnings are imported automatically and translated into a predictable set of phrases that are used to report the event via 511 and other public channels. The software filters out warning types that are not immediately relevant to roadway users, such as general weather “statements” and short-term forecasts. Weather reporting is thus reserved for critical events such as flash floods, severe thunderstorms, and blizzards.

CARS-CAP events are presented in two formats: area-based and roadway-based. Area reports are based on NWS zones, which in many cases are equivalent to counties or parishes. Each area-based event is also “mapped” to sections of major highways crossing that zone. This allows CAP warnings to be announced on CARS-511 when callers select a highway number.

This presentation will discuss the challenges faced by Castle Rock in transitioning from CAP 1.0 to the new CAP 1.1 specification. It will also discuss possible future developments to CARS-CAP, such as expanding the software to include other NWS and CAP-based products, such as Homeland Security Alerts.

4B1.1 ID:5087 INVITED/INVITÉ 10:30

New tools for evaluating spatial forecasts: MET and MODE

Barbara Brown , *Tressa Fowler* , *John Halley Gotway* , *Randy Bullock*
NCAR
Contact: bgb@ucar.edu

In recent years, a number of new tools have been developed for diagnostic evaluation of spatial forecasts. These tools include object, neighborhood, scale separation, and field deformation approaches. Simultaneously, a new toolkit for verification and evaluation of model-based forecasts has been developed by the U.S. Developmental Testbed Center and made available to the forecasting and verification communities. This toolkit, the Model Evaluation Tools (MET), has been designed to provide traditional (i.e., “score-based”) methods for verification, as well as new state-of-the-art spatial verification approaches. Currently, MET has tools for neighborhood, scale-separation, and object-based methods. The object-based method included in MET is the Method for Object-based Diagnostic Evaluation (MODE). MODE uses a smoothing and thresholding process to identify weather objects in the forecast and observed fields and then identifies and compares specific features in matched forecast and observed objects.

This talk will provide an overview of MET and the tools that it includes, as well as the philosophy of MET development. MODE will be discussed in more detail, including some consideration of new and future capabilities. For example, while most of the spatial approaches have been developed for and applied to precipitation forecasts, MODE has also been applied recently to wind and other types of forecasts. In addition, new MODE developments focus on incorporation of the time dimension in the identification and comparison of forecast and observed objects.

1P301.3 ID:5088 16:00

Estimating the exchange flow through a canyon; a scaling analysis

Susan Allen [1], *Barbara Hickey* [2]
[1] Earth and Ocean Sciences, University of British Columbia
[2] Oceanography, University of Washington
Contact: sallen@eos.ubc.ca

The response over a submarine canyon to a several day upwelling event can be separated into three phases: an initial transient response; a later, much longer, “steady” advection-driven response; and a final relaxation phase. For the advection-driven phase over realistically steep, deep, and narrow canyons with near-uniform flow and stratification at rim depth, we have derived scale estimates for four key quantities. Based on 4 geometric parameters of the canyon, the background stratification, the Coriolis parameter, and the incoming current, we can estimate (1) the depth of upwelling in the canyon to within 15 m, (2) the deep vorticity to within 15%, and (3) the presence/absence of a rim depth eddy can be determined. Based on laboratory data, (4) the total upwelling flux can also be estimated. The scaling analysis is compared to results from field observations and laboratory canyons. Implications for flux of nutrients onto the shelf will be discussed.

3P208.1 ID:5089 15:30

Simulated Climatologies in Areas with Sparse Data Records: an Implementation of a Meteorological Information System

Jeff Lundgren , *Ron Chapman* , *Valerie Sifton* , *Paul Joynt*
RWDI AIR Inc.
Contact: jeff.lundgren@rwdi.com

In some areas of the globe, stations recording historical meteorological data of the type required for air quality studies and building design are sparsely located. When data from stations are available they may display reduced periods of record and/or contain many missing or specious records. Often these areas of data paucity correspond to regions where human development is progressing at a great pace. As a result, there frequently is a lack of representative meteorological data necessary to inform scientific and engineering activities in such regions.

To address this problem, RWDI applied the WRF mesoscale model to create high resolution multi-year simulated climatologies over two such regions: The Middle East and Arabian Peninsula; and The People's Republic of China. The model was configured in a 36km, 12km and 4km nested grid to produce detailed simulated meteorological histories over the area of greatest development in both regions. The initial model period was 5-year in each location, with plans to extend through to 10 years.

A Meteorological Information System (MIS) was developed to extract output fields from the model histories. MIS also maintains an inventory of historical measurement data from thousands of meteorological stations from around the globe. At the core of MIS is a relational database that is used to store the data. Model outputs and historical data can be extracted via a user interface using Geographic Information System (GIS) techniques. Historical station data can be quickly viewed using standard graphs and reporting techniques while raw data can be exported as comma separated value (CSV) files.

Model outputs may be extracted for use with standard regulatory models such as CALPUFF, AERMOD and ISC. The fields are also suitable to nest further WRF runs finer that 4km resolution or to drive photochemical modelling. In addition model data will also be used to inform building load and effects studies of super-tall structures in as well as sustainable design and master planning. Data in both regions may be extracted for use in any other discipline for which site representative meteorological are necessary.

4D2.2 ID:5090 15:45

ClimateWNA: Access to high spatial resolution climate data for western North America

David Spittlehouse [1], *Tongli Wang* [2], *Andreas Hamann* [3], *Trevor Murdock* [4]
[1] Innovation Branch, BC Ministry of Forests, Mines and Lands
[2] CFCG, Univ. British Columbia
[3] Dept. Renewable Resources, U. Alberta
[4] Pacific Climate Impacts Consortium, U. Victoria
Contact: dave.spittlehouse@gov.bc.ca

ClimateWNA is a stand-alone MS Windows-based computer program that enables users to obtain selected monthly climate variables based on latitude, longitude, and elevation for any point in western North America. The data represent weather station climate and variables include maximum, minimum and average monthly temperature, total precipitation and a suite of annual derived variables such as degree days and frost free period. ClimateWNA's uses a 4 km grid of monthly temperature and precipitation for the 1961-90 normals created using PRISM as its base data. The software bi-linearly interpolates the 4 km PRISM data to the latitude and longitude of interest and an elevation adjustment is then applied to the interpolated monthly values. Bi-linear interpolation provides adequate adjustment for monthly precipitation. Historic climate data and future conditions simulated by GCMs are available. The latter are obtained by applying GCM temperature and precipitation anomalies for the 2020s, 2050s and 2080s interpolated to 1° latitude by 1° longitude grid to the based data. A comparison was made between monthly normals for 2281 weather stations across western Canada and the US and values predicted by ClimateWNA. Standard errors for predicted monthly temperature varied from 0.6 to 1.1°C depending on the month and temperature variable. Monthly precipitation had a standard error of 3 to 10 mm.

3P410.2 ID:5091 15:30

Climate change in the Atlin-Taku region of northern British Columbia

Stephen Sobie , *Trevor Murdock*
Pacific Climate Impacts Consortium
Contact: ssobie@uvic.ca

The Atlin-Taku region of BC resides near the BC-Yukon border and is expected to experience significant increases in temperature and changes in precipitation over the next 100 years. During the latter half of the 20th century this region experienced increases in mean annual temperature of 0.2-0.3°C per decade and increases in precipitation of 0-5% per decade with significant spatial variation due to its steep topography. These trends are further projected to grow through the end of the 21st century. At present, orographic effects limit precipitation for the area, leaving the existing vegetation and glacially-fed river systems sensitive to shifts in temperature and precipitation. Current future climate projections suggest an increase in the number of Growing Degree Days, Frost Free Days and Summer Heat to Moisture Ratio will lead to changes in the hydrology as well as the habitable zones for a wide variety of plant species in the area.

In order to examine an extended range of future climate scenarios, climate models from the IPCC Fourth Assessment Report and the University of Victoria Earth System Climate Model (UVicESCM) are employed to produce projections for the Atlin-Taku region. The future scenarios selected include those of SRES, the recent Representative Concentration Pathways and mitigation scenarios. The performance of the UVicESCM in this region is tested to confirm whether it is a suitable proxy for the climate models from the IPCC. Additionally, future climate variables are also statistically downscaled using the LARS-WG method to produce local representations of temperature and precipitation changes.

4B1.2 ID:5092 11:00

Investigations of Spatial Verification Techniques for Ensemble Forecasts of Precipitation during Heavy Precipitation Events along the United States West Coast

Edward Tollerud [1], *Tara Jensen* [2], *Tressa Fowler* [2], *Barb Brown* [2], *John Halley Gotway* [2], *Paul Oldenburg* [2], *Randy Bullock* [2], *Isidora Jankov* [3]
[1] Developmental Testbed Center and Global Systems Division, ESRL/NOAA
[2] Developmental Testbed Center and National Center for Atmospheric Research
[3] Developmental Testbed Center and the Cooperative Institute for Research in the Atmosphere
Contact: edward.tollerud@noaa.gov

During several winter seasons since 2005, the NOAA Hydrometeorological Testbed (HMT), in collaboration with local NWS forecast offices and River Forecast Centers, have performed winter exercises along the Pacific Coast of the United States. A focus of these exercises has been the improvement of numerical quantitative precipitation forecasts (QPF) through the use of regional high-resolution ensemble forecast systems. For the exercises in 2009-10 and 2010-11 the Developmental Testbed Center (DTC) has provided real-time and retrospective verification of these and other operational forecasts. Along with traditional QPF verification measures, the evaluations have also included prototype spatial verification techniques from the MET/MODE verification package. We apply these techniques to the ARW ensemble member QPF and related probabilistic products to investigate which ensemble members and other forecasts might produce clearly superior representations of the spatial structure and other attributes of severe rainfall events in the strongly orographic precipitation regime of the HMT model domain. In addition to placement, the predicted intensity and duration of these events is evaluated using different QPE products including Stage IV gridded gage analyses and model analyses such as the LAPS product from GSD/ESRL. We discuss how these results can be related to similar verification of forecasts of larger-scale phenomena

(principally ‘atmospheric rivers’) that appear to be principal driving mechanisms for extreme precipitation within this domain.

3C3.2 ID:5093 13:45

Why the spring phytoplankton bloom is moving earlier in the year in the Strait of Georgia but later in the year in Rivers Inlet

Susan Allen [1], *Kate Collins* [2], *Megan Wolfe* [1]
[1] Earth and Ocean Sciences, University of British Columbia
[2] Bedford Institute of Oceanography, Fisheries and Oceans, Canada
Contact: sallen@eos.ubc.ca

A coupled-biophysical model was used to investigate the timing of the spring bloom in two estuarine systems: a classic fjord (Rivers Inlet - RI) and the Strait of Georgia -SoG. Model results were compared to observations to validate. Then the forcing parameters (light through variations in clouds, freshwater, winds) were varied to determine their impact. In both systems, the spring bloom occurs when the light-limited growth can exceed the loss terms. Light is directly important to the growth; strong winds limit the light phytoplankton receive by deepening the mixing layer; freshwater increases the light phytoplankton receive by shallowing the mixing layer. The latter two also impact the loss terms as both can increase advection of the surface layer out of the system. The difference in the physics between the two systems and thus the difference in the growth/loss balances leads to recent delay of the spring bloom in RI but advancement in SoG.

The SoG model has been used to predict timing of each years bloom. It was successful in 2006, 2008 and 2009. In 2010 the prediction was slightly early whereas in 2007 the prediction was late. We will discuss the limitations of the predictions, the reasons for success and failure and why a similar system cannot be used for RI.

1C5.5 ID:5094 15:15

Observationally-constrained projections of 21st century changes in temperature and precipitation

Nathan Gillett [1], *Xuebin Zhang* [2]
[1] CCCma, Environment Canada, Victoria, BC
[2] Climate Research Division, Environment Canada, Toronto, ON
Contact: nathan.gillett@ec.gc.ca

A detection and attribution analysis can be used to estimate the scaling factors by which simulated surface temperature responses to greenhouse gases, sulphate aerosols and natural forcings should be scaled to best match observations over the historical period. These scaling factors, along with their associated uncertainties, may then be used to derive observationally-constrained projections of future temperature change, by scaling up or down simulated future warming. We apply this technique to derive observationally-constrained projections of 21st century temperature change using simulations from the Canadian Earth System Model. Previous such analyses have constrained projections using observed temperature changes to 2000: We investigate the influence on projected future warming of including observations from the past decade during which global mean temperature has warmed less strongly. We also, for the first time, discuss the application of this approach to precipitation, a variable whose response to anthropogenic forcing is underestimated by most models.

4C0.6 ID:5095 14:45

Observationally-based datasets for ocean acidification modelling

Robin Matthews
University of Victoria, Climate Modelling Group, School of Earth and Ocean Sciences
Contact: georobin@uvic.ca

In the past decade ocean acidification caused by dissolution of anthropogenic CO2 into the global ocean has been recognized as a potentially serious threat to the functioning of present-day ocean ecosystems. Scientific understanding is rapidly advancing in this field of complex interdisciplinary study. To better evaluate model projections of ocean acidification there is a need to develop global-scale observationally-based datasets for the full-suite of measured carbonate chemistry parameters (pH, pCO2, DIC and Total Alkalinity). It is useful for these to resolve sub-annual timescales so as to better characterize seasonal variability, the background from which longer-term trends are distinguished. Here a new global dataset for model evaluation is discussed. This open ocean product was constructed using the Takahashi surface pCO2 climatology and Lee formulations for computing surface Total Alkalinity. It is compared with inorganic carbon observations from a variety of ocean time series stations and a seasonal climatology for the Southern Ocean.

3C2.4 ID:5096 14:30

Future projections of fire weather severity in Southeastern British Columbia using statistical downscaling

Derek Van Der Kamp , *Gerd Bürger*
Pacific Climate Impacts Consortium
Contact: derek.vanderkamp@gmail.com

Climate is a primary driver of wildfire. It is therefore likely that a changing climate will lead to shifts in the severity, location, and timing of wildfire in Canada. One way of quantifying such changes is to create future projections of indices within the Canadian Fire Weather Index system (FWI). The FWI is a series of indices calculated from temperature, precipitation, wind speed and relative humidity that provide an indication of fire weather severity. However, it is difficult to accurately simulate these surface variables within BC using global climate models as they do not resolve the complex topography and significant climatological gradients of the region. In order to address these issues we use a statistical downscaling procedure to create projections of the FWI input variables for seven stations located throughout Southeast British Columbia. In detail, the downscaling approach involves an extension of classical multiple linear regression that preserves inter-variable and inter-station covariance. This technique is well suited for the modelling of multiple variables and stations required here. We attempt to incorporate the inherent uncertainties in making future climate projections by using three different GCMS (CGCM3, HADGEM2 and ECHAM5) and two different emissions scenarios (A1b and A2). Observed historical climatologies of the FWI input variables were well simulated using NCEP reanalysis. Preliminary results show a large range of FWI projections which encompasses both increases and decreases in fire weather severity. These uncertainties can be traced back to the large range in precipitation projections across scenarios and models.

4D0.3 ID:5097 16:00

Why is global warming proportional to cumulative carbon emissions?

Nathan Gillett [1], *Vivek Arora* [1], *Kirsten Zickfeld* [2], *Damon Matthews* [3]
[1] CCCma, Environment Canada, Victoria, BC
[2] Department of Geography, Simon Fraser University, Burnaby, BC
[3] Geography, Planning and Environment, Concordia University, Montreal, QC
Contact: nathan.gillett@ec.gc.ca

Several recent studies have demonstrated that global mean temperature change is approximately proportional to cumulative carbon emissions in coupled carbon-climate models on timescales of decades to centuries, and for a wide range of CO_2 emissions scenarios. A cancellation of the effects of the saturation of carbon sinks with increasing atmospheric CO_2 and the logarithmic dependence of radiative forcing on CO_2 concentration has been proposed as an explanation of the scenario-independence. The timescale-independence has been ascribed to the mixing of heat and carbon into the ocean by similar processes with similar timescales. We present a simple analytical model of the climate system which displays proportionality between cumulative carbon emissions and temperature. We test this analytical model using idealised simulations from the Canadian Earth System Model, and evaluate proposed explanations for the proportionality of temperature to cumulative emissions.

3P410.1 ID:5098 15:30

Climate Change Adaptation Planning Using High-Resolution Remote Sensing

Taylor Davis
Terra Remote Sensing, IEEE member
Contact: taylor.davis@terraremote.com

As climate models are predicting more erratic weather patterns and greater extremes - whether it is prolonged drought, more intense rainfall, or temperature swings - planning for these fluctuations at regional levels is a difficult task. It is clear that future climates will have to be adapted to, however questions remain as to what level of implementation will be needed, or is possible, in order to protect our communities from future risk and economic loss. Some of these questions can be answered by advanced remote sensing technology. Integrated airborne LiDAR, hyperspectral and digital image data can be used to solve a range of complex and interconnected issues. Detailed assessments of physical surficial characteristics, infrastructure and ecology, can be carried out using integrated remotely sensed data.

This presentation will focus on the technology and data application over the City of Victoria. In July 2010 Terra Remote Sensing captured LiDAR, hyperspectral and digital orthophotos over Mount Douglas Park, Swan Lake Christmas Hill Nature Sanctuary and urban areas of Saanich. Terra, in collaboration with the University of Victoria, will use a 1 square kilometer tile as a case study to extract multiple datasets to demonstrate the utility of integrated remotely sensed data for detailed climate change adaptation planning. Data sets will include: detailed ground surface classification, drainage models for stormwater management, above ground biomass quantification, species identification, carbon sequestration estimation and solar energy harvesting potential. These data are invaluable resources for use by planners in energy, land use, and climate change adaptation to carry out detailed assessments and subsequent modeling. The results of which provide the foundation to the cost/benefit analysis of various methods of adaptation to the anticipated climactic changes.

1C2.3 ID:5099 14:30

A New Modern Tropospheric Radar Wind Profiler for Research and National Networks

Scott Mclaughlin
DeTect, Inc.
Contact: scott.mclaughlin@detect-inc.com

A modern radar wind profiler designed for stratosphere- troposphere (ST) operational use has been designed, manufactured and delivered to the US NOAA National Weather Service. The system uses digital receiver technology, full system monitoring, solid-state antenna beam pointing technology, full beam steering (FBS) and advanced signal processing techniques. This system is also scalable for the transmitter and antenna allowing boundary layer through ST systems to be produced with the same parts. The US NWS has selected this system to replace the older 404 MHz systems which constitute the NOAA Profiling Network which began operations in the US Midwest in the 1992. This new Next Generation NPN (NGNPN) will use 30+ of the new systems. A demonstration system was manufactured and operated in 2009 with four more systems now in production. The remaining systems will be produced and installed over the next 4 years. The systems produced for the NWS can capture data from 160 m to 16 km with real-time 6 and 60 minute data reporting. A system description and data will be presented.

1C0.4 ID:5100 15:00

Spatial and temporal comparisons of CMAQ and AURAMS modelling runs at 12-km resolution over coastal BC

Robert Nissen , *Paul Makar* , *Colin Di Cenzo* , *Andrew Teakles* , *Harry Yau* , *Junhua Zhang* , *Qiong Zheng*
Meteorological Service of Canada
Contact: robert.nissen@ec.gc.ca

The Community Multiscale Air Quality (CMAQ) and A Unified Regional Air-quality Modelling System (AURAMS) models were run at 12-km resolution over coastal British Columbia for a one-month period in the winter (January 28-February 28) and the summer (July 15-August 15) of 2005. Outputs from the Global Environmental Mesoscale (GEM) Regional model provided the driving meteorology for both air quality models. Identical emission inventories and grid domains were employed. In this presentation, spatial patterns of modelled ozone and PM2.5 are demonstrated for several summer and winter weather patterns. Diurnal variations are compared with ground observations for various coastal and interior locations.

1B5.4 ID:5101 12:15

Ocean biogeochemistry in the enhanced greenhouse: the ocean carbon cycle in simulations with the Canadian Earth System Model

James Christian [1], *Nadja Steiner* [1], *Warren Lee* [2], *Kenneth Denman* [3]
[1] Fisheries and Oceans Canada / Canadian Centre for Climate Modelling and Analysis
[2] Environment Canada / Canadian Centre for Climate Modelling and Analysis
[3] VENUS Network, University of Victoria / Canadian Centre for Climate Modelling and Analysis
Contact: jim.christian@ec.gc.ca

Ocean uptake of anthropogenic carbon dioxide has substantially mitigated the effect of anthropogenic emissions on climate. Climate change and ocean acidification will affect future rates of ocean carbon

dioxide uptake, and have likely already begun to do so. Both positive and negative feedbacks are possible, but the overall effect is likely to be reduced ocean uptake and therefore a greater airborne fraction of future emissions. The Canadian Earth System Model CanESM is a fully coupled climate/carbon-cycle model with prognostic ocean and terrestrial carbon cycle models. The model has been used to simulate the historical climate using known emissions, and future climates using IPCC scenarios. The latest simulations are conducted with CanESM version 2, whose ocean model has substantially enhanced vertical and horizontal resolution, and a variety of new mixing parameterizations to give a more realistic ocean circulation. In this talk we will review the effects of future climate change on the ocean's biological pump and ocean-atmosphere exchange of carbon dioxide, the expansion of regions of calcite and aragonite undersaturation, and the biogeochemical impacts of interannual to interdecadal climate variability in the coming climate, emphasizing the differences between CanESM2 and its predecessor CanESM1, and prospects for analysis of the full suite of models in the upcoming IPCC model intercomparison.

2B2.5 ID:5102 11:30

CODECON retirement and its resultant improvement of atmospheric data from MSC automatic monitoring sites.

John Macphee
MSC - Monitoring
Contact: john.macphee@ec.gc.ca

The Data Management System (DMS) is an MSC project designed to improve access to, and management of MSC and partner data. This project, which has been underway for several years, is now at a point where it is retiring CODECON, the software package between the atmospheric monitoring sensors and the archive. CA Decode, the first of many replacement modules for CODECON, is scheduled to go live in July 2011. The CA Decode module will allow us to transfer previously stranded data, such as minutely tipping bucket output and RF-1 radiation data, from sensor to the archive. We are also in the process of porting existing algorithms from CODECON to CA Decode, as well as writing new algorithms to meet the requirements of triple configurations on several sensors. These changes will eventually affect almost all measurements taken at MSC automated observing stations. This talk will highlight the changes which the CA Decode module will bring to: snowfall measurement, total precipitation measurement, rainfall intensity reporting, RF-1 data, temperature, and its potential to change the frequency of reports.

1P205.3 ID:5103 16:00

Statistical comparison of CMAQ and AURAMS modelling runs at 12-km resolution over coastal BC

Robert Nissen , *Paul Makar* , *Colin Di Cenzo* , *Andrew Teakles* , *Harry Yau* , *Junhua Zhang* , *Qiong Zheng*
Meteorological Service of Canada
Contact: robert.nissen@ec.gc.ca

The Community Multiscale Air Quality (CMAQ) and A Unified Regional Air-quality Modelling System (AURAMS) models were run at 12-km resolution over coastal British Columbia for a one-month period in the winter (January 28-February 28) and the summer (July 15-August 15) of 2005. Outputs from the Global Environmental Mesoscale (GEM) Regional model provided the driving meteorology for both air quality models. Identical emission inventories and grid domains were

employed. In this poster the two models' performance relative to ground observations will be assessed for several coastal and interior locations with emphasis on the ozone and PM2.5 fields.

4C2.2 ID:5104 14:00

BCSD Downscaled Transient Climate Projections for Eight Select GCMs over British Columbia, Canada

Arelia Werner
Pacific Climate Impacts Consortium
Contact: wernera@uvic.ca

The Pacific Climate Impacts Consortium (PCIC) has quantified the hydrologic impacts of projected climate change in three BC watersheds for the 2050s, with particular emphasis on sites corresponding to BC Hydro power generation assets. The first step in this work was to screen global climate models (GCMs) based on a number of performance metrics over the globe and western North America to arrive at a subset that represented a defensible range in possible futures. Selected GCMs forced with three emissions scenarios (B1, A1B and A2) were then statistically downscaled to the 1/16° grid-scale at a daily time step and downscaled outputs were subsequently used to force a hydrologic model to assess and analyze the projected hydrologic response to climate change. The Bias Corrected Spatial Disaggregation (BCSD) statistical downscaling technique was chosen for application in this case due to its extensive use, particularly in previous hydrologic modelling studies and projections of future precipitation, minimum temperature and maximum temperature were created for BC. This technique was validated by comparing BCSD downscaled NCEP results to gridded-observed data at the 1/16° grid-scale for 1991-2000. Downscaled results were found to be representative of observed magnitudes and patterns of average temperature and total precipitation over the province and matched the explained variance of the gridded-observations at the 99% confidence interval for several indices of temperature and precipitation extremes. The downscaling of several GCMs run under three emissions scenarios allowed for the range in uncertainty due to GCMs versus emissions scenarios to be explored. The range between temperature and precipitation projections was greater for multiple GCMs than it was for emissions scenarios both annually and seasonally in the 2050s. Although these climate projections were originally developed to generate hydrologic projections, these results are applicable to inform adaptation within a broad range of impact studies across BC.

2B5.4 ID:5105 11:30

Seasonal dynamics of microbial mat growth at the VENUS observatory in Saanich Inlet, British Columbia

Kim Juniper , *Courtney Dean* , *Katleen Robert* , *Marjolaine Matabos*
University of Victoria
Contact: kjuniper@uvic.ca

Filamentous mats of autotrophic, sulphide-oxidizing bacteria are common in areas of seafloor subject to low-oxygen conditions, where there is a local source of hydrogen sulphide. Typical habitats in coastal areas range from micro-scale patches of mat on organic-rich sediments to more extensive growth associated with net pen aquaculture installations and basin scale hypoxia. Autotrophic microbial mats have been identified as an important food source at deep-sea hydrothermal vents, where grazing by invertebrates often limits the accumulation of mat material. In coastal waters, hypoxia and the presence of sulphide usually exclude sessile benthos from areas of abundant mat growth but demersal fish and mobile benthic invertebrates are occasionally present. In 2009-2010 we

undertook a 13-month study of microbial mat dynamics using cameras and instruments linked to the VENUS seafloor observatory (103m depth) in Saanich Inlet, a British Columbia fjord. Our primary goal was to develop methods for the study of interactions between bacterial mat growth, the annual cycle of anoxia/hypoxia and the activities of benthic invertebrates and fish. Remotely-controlled camera sweeps, 2-3 times per week, documented mat growth and the abundance and activity of benthic organisms. Image analysis used a perspective grid to quantify surface area occupied by microbial mats. The primary determinant of mat abundance was an inverse relationship with dissolved oxygen concentration. In addition, data reveal notable periods where coverage of sediments by mat material was disrupted by fish bioturbation and possibly grazing by invertebrates. Episodes of reduced visibility affected the accuracy of our determinations of mat coverage and faunal abundance. We will present a model of bacterial mat growth in relation to dissolved oxygen concentration and faunal activity that includes error terms that account for reduced visibility and patchiness of mat coverage.

4D1.4 ID:5106 16:30

Issues of spectral nudging and domain size in studies of limited- area RCM response to modification

Leo Separovic [1], *Ramon De Elia* [2], *René Laprise* [1]
[1] Université du Québec à Montréal
[2] Consortium Ouranos
Contact: leoseparovic@gmail.com

This work aims at finding some optimal, pragmatic high-resolution RCM configuration, less computationally demanding than the operational RCM runs, to serve as a test bed for quantifying model response to modification of parameters in model configurations. The approach followed consists in analysis of the sensitivity of RCM-simulated seasonal averages to perturbations of two parameters controlling deep convection and stratiform condensation.

The sensitivity is analyzed within different simulation configurations obtained by varying domain size and using spectral nudging option. For each combination of these factors multiple members of identical simulations that differ exclusively in initial conditions are also generated to provide robust estimates of the sensitivities (the signal) and associated internal variability (the sample noise). The configurations are compared in terms of the signal response and the associated computational cost of achieving statistically significant estimates of the signal. The results show that the noise magnitude is decreased both by reduction of domain size and application of spectral nudging. At the same time, spectral nudging has the advantage of not considerably altering the sensitivity patterns, unlike the case with reduced domain size.

1B1.3 ID:5107 11:45

Nowcasting for SNOW-V10 using Adaptive Blending of Observations and Model Data

Monika Bailey , *George Isaac*
Environment Canada
Contact: monika.bailey@ec.gc.ca

The ABOM (Adaptive Blending of Observations and Model) Nowcasting system was tested in real time during the 2010 winter Olympics and Paralympics in British Columbia. Data at one minute time resolution was available from a dense network of surface observation stations. This, combined with new high resolution numerical models, provided a setting to test a nowcasting system in mountainous terrain and in winter weather. The ABOM method blends extrapolations of recent observations with model predictions to generate point forecasts of surface variables (temperature, RH, winds, visibility and ceiling) at 15 minute steps out to six hours. The relative weights of the model forecast and the observation extrapolation are based on performance over recent history. Further adjustments are made with site specific tuning parameters. The Olympic ABOM forecasts were updated every 15 minutes with new observation data. The average performances of ABOM forecasts during February and March 2010 were evaluated using standard scores for continuous and for categorical variables based on thresholds important for particular Olympic events. Scores were calculated both as functions of forecast lead time and of time of day. Performance during several short critical weather events was also evaluated. Significant improvements over the model alone were obtained for continuous variables such as temperature or relative humidity at short lead times. Small improvements to forecasts of variables such as visibility and ceiling, subject to discontinuous changes, are attributed to a persistence component. The importance of high time resolution observation data and high spatial resolution of model data is discussed and recommendations for future implementations of ABOM are made.

4C0.5 ID:5108 14:30

The effect of changing radiant energy on carbon transformations in the Arctic Ocean

Sophia Johannessen , *Robie Macdonald*
Fisheries and Oceans Canada, Institute of Ocean Sciences
Contact: sophia.johannessen@dfo-mpo.gc.ca

Almost all of the visible and UV radiation that enters the ocean is absorbed. There is a balance among absorbance by organic matter (leading to photochemical reactions and fading), phytoplankton, water and detritus. Some of the energy absorbed by these different components causes carbon transformations, which eventually lead to heat or to burial of organic carbon. Photosynthesis takes up carbon dioxide, for example, producing organic matter at higher thermodynamic potential than carbon dioxide, while the photochemical oxidation of organic matter represents the reverse process. In the Arctic, the loss of sea ice and permafrost will increase the total radiant energy that enters the ocean, while also changing its spectral distribution and the role played by coloured dissolved organic matter. Because the absorption of radiation by the various components is spectrally dependent, not only will the absolute rate of energy absorption change, but so will its relative effect on the transformations of carbon, both in autotrophy and heterotrophy. We will illustrate the current balance of energy absorption in the Arctic Ocean and how that translates now and in the future into the uptake, production and long-term storage of carbon dioxide.

1P406.2 ID:5109 16:00

Examination of Historical Climatic Drivers of Streamflow Generation in the Athabasca River Watershed: A Focus on Precipitation and Climate Oscillations

Daniel Peters [1], *David Atkinson* [2], *Donald Baird* [3], *Wendy Monk* [3], *David Tenenbaum* [4]
[1] Environment Canada @ W-CIRC
[2] Dept. Geography, University of Victoria
[3] Environment Canada @ Canadian Rivers Institute
[4] Dept. Env, Earth, Ocean Sciences, Univ. Massachussetts
Contact: daniel.peters@ec.gc.ca

The Athabasca River (~1350 km, ~160,000 km2) in northwestern Canada originates at the Columbia Icefields in the Rocky Mountains of southwestern Alberta and drains mountain, foothill and lowland terrains prior to emptying into Lake Athabasca and the Peace-Athabasca Delta complex. The watershed is influenced by multiple environmental stressors, of which the latest growing concern is water abstraction for oil-sands processing, with potential downstream effects on the hydrology and aquatic ecology. A number of studies have reported declining Athabasca River streamflows in recent decades. In particular, Schindler and Donahue (2006) reported that the mean May to August flows on the lower Athabasca River mainstem declined by 20% from 1958 to 2003 and 33% from 1970 to 2003. The authors predict that in the near future climate warming, via its effects on glaciers, snowpacks, and evaporation, will combine with cyclic drought and rapidly increasing human activity in the prairies to produce a water availability crisis. Historical streamflow declines have been observed and indications are that these may continue into the future, potentially placing the Athabasca River in the 'Red Zone' of the Instream Flow Needs management guidelines developed by Department of Fisheries and Oceans with Alberta Environment during the winter low flow period. Environment Canada is currently investigating the implications associated with decreasing seasonal flows and decreasing magnitude in ecologically relevant hydrograph variables (e.g., peak and minimum flows) for connectivity and integrity of the Peace-Athabasca Delta system. As part of this study, the objective of this poster is to present our preliminary investigations of inter-annual and multi-decadal variability of precipitation in the mountain, foothill and lowland zones of the Athabasca River Watershed. In addition, potential linkages with climatic oscillations/patterns (i.e., Pacific Decadal Oscillation (PDO) and Pacific/North American (PNA) pattern)that have been found to be factors influencing precipitation and streamflow variability/low frequency cycles in western Canada will be explored.

2D1.1 ID:5110 INVITED/INVITÉ 16:00

Progress and future directions of the Canadian weather and environmental prediction and services systems : optimizing research to operations mechanisms.

Michel Jean
(Presented by *Dave Wartman*)
Meteorological Service of Canada
Contact: michel.jean@ec.gc.ca

The Meteorological Service of Canada is one of the six most advanced and competitive meteorological and hydrological services in the world, covering one of the world's largest surface areas, and serving one of the most weather-affected societies in the world. The combination of a relatively small resource base, enormous land and water area of responsibility, and severity and diversity of weather makes the MSC a uniquely challenged and extremely successful organization. Its position among the most advance handful of weather services makes it competitive far beyond its class in terms of results for resource base. This is a result of its key investments in research, science, and utilization of resources to best advantage. In particular, its research to operation technology transfer mechanisms, benefiting half a century of improvements, is looked at by many developed and emerging meteorological organizations. The next few years will see another significant increase in science and technological capability at a time when MSC remains resource limited, yet the opportunities remain for significant advances if investments are made in key areas. The MSC has selected a number of key areas in which to invest, and translated these into specific initiatives which will move forward as key elements of its overall strategic direction. These 'signature projects' span the range of research, operations, and services and will establish key infrastructure to allow the MSC to move forward with an enterprising agenda based on science and the capacity of its scientific and service personnel. This presentation will outline the major components of MSC's strategy, describe it's key initiatives, and provide an update on MSC's direction over the next several years

2D1.2 ID:5111 16:30

A service strategy for the Meteorological Service of Canada

Ken Macdonald
(Presented by *Joanne St-Coeur*)
Meteorological Service of Canada
Contact: ken.macdonald@ec.gc.ca

Technological change is rapidly and radically altering the ways in which Canadians access weather and environmental information and scientific advances are bringing forward an ever-increasing array of possible weather and environmental information that will be of interest to Canadians. Consequently, the Meteorological Service of Canada, as a primary and authoritative source of such information in Canada, is rethinking and updating its strategies for service delivery. The service strategy takes into consideration the range of clients served by the government weather service and the service goals that are relevant for each. Details of the strategies include a fundamental re-engineering of the Environment Canada weather warning system and the use of wireless technologies to distribute information. The presentation will include an opportunity to input to and influence the MSC Service Strategy as it is being developed.

2C3.1 ID:5112 14:00

An algorithm for constructing 3D cloud fields from profiles retrieved from active-passive satellite data

Howard Barker
Meteorological Service of Canada (ARMP)
Contact: howard.barker@ec.gc.ca

An algorithm is presented that constructs 3D distributions of cloud (as well as aerosol, temperature and moisture, and surface properties) from passive satellite imagery and collocated nadir profiles of cloud properties inferred synergistically from lidar, cloud radar, and imager data. It effectively widens the active-passive retrieved cross-section (RXS) of cloud properties thereby enabling computation of radiative fluxes and radiances which can be compared to measured values in an attempt to perform radiative closure experiments that aim to assess the RXS. A-train data were used to verify the scene construction algorithm. Constructed scenes were acted on subsequently by a 3D solar radiative transfer model.

The construction algorithm fills off-RXS recipient pixels by computing sums of squared differences (a cost function F) between their spectral radiances and those of potential donor pixels/columns on the RXS. Of the RXS pixels with F less a certain value, the one with the smallest Euclidean distance to the recipient pixel is designated as the donor and its retrieved cloud properties, and other attributes such as surface properties, are consigned to the recipient. It is shown that both the RXS itself and MODIS imagery can be reconstructed extremely well using just a visible and thermal IR channel. Suitable donors usually lie within 10 km of the recipient.

Domain-average 3D broadband radiative fluxes at top of atmosphere (TOA) for (21 km)^2 domains constructed from MODIS, CloudSat, and CALIPSO data agree well with coincidental values derived from CERES radiances: differences between modelled and measured reflected shortwave fluxes are within ±10 W m-2 for ~35% of the several hundred domains constructed for eight orbits. Correspondingly, for outgoing longwave radiation ~65% are within ±10 W m-2.

1P306.2 ID:5113 16:00

Storm surge forecasting for coastal British Columbia

Scott Tinis [1], *Richard Thomson* [2]
[1] Lorax Environmental Services, Ltd.
[2] Fisheries and Oceans Canada
Contact: stinis@islandnet.com

Extreme ocean water levels due to the combination of storm surge and high tides pose a significant threat to low lying coastal communities in British Columbia, many of which are protected from coastal flooding by aging dyke systems. Storm surge frequency and intensity are shown to be modulated by the El Nino/La Nina cycle which affects seasonal sea surface height anomalies over the continental shelf. A thirty year hindcast of storm surge for the October to March period using the Princeton Ocean Model forced by the NCEP North American Regional Reanalysis wind and atmospheric pressure fields is compared to observations from Alaska to Northern California, with a particular emphasis on southern British Columbia. The effect of model resolution, alternate wind model forcing and inclusion of tide-surge interaction between Juan de Fuca Strait and the Strait of Georgia is discussed. Finally, the application of numerical forecasting of storm surge is examined using case studies over the past thirty years for the Lower Mainland of British Columbia, with the goal of creating an accurate and dependable operational storm surge warning system.

1P306.1 ID:5114 16:00

Coastal water column observations using the NEPTUNE Canada Ocean Network: Recent developments

Steven Mihaly
NEPTUNE Canada, University of Victoria
Contact: smihaly@uvic.ca

NEPTUNE Canada affords a wide range of opportunities to conduct adaptive and high-temporal resolution water column property studies. Intensive sites are located in shallow near-shore environments (Folger Pass), and the continental shelf-break (Barkley Upper Slope). Folger Pass has instrument platforms at 100m and 25m which are located near the mouth of Barkley Sound on the west coast of Vancouver Island. Instruments include: upward-looking surface-wave resolving Acoustic Doppler Current Profilers (ADCPs), multi-frequency echo-sounders and a bottom pressure recorder . Near-bottom waters are sampled for salinity, temperature, oxygen, chlorophyll, turbidity, photosynthetically active light and, in addition, there are also fine scale measurements of the velocity structure of the bottom-boundary layer. Results from a novel Vertical Profiling System (VPS) recently tested in Saanich Inlet and deployed at the 400 metre deep Barkley Upper Slope site. This winch operated system profiles a variety of instruments throught the water column: optical measurements consist of a pair of hyperspectral radiometers to characterise downwelling irradiation and upwelling radiance, backscatter fluorescence for chlorophyll, and an optode to determine oxygen levels. A pumped CTD will provide salinity, temperature, depth as well as plumbing for a nitrate sensor, coloured dissolved organic matter sensor and pCO2 sensor. Acoustic instruments on the profiler consist of a 400 kHz ADCP, 125kHz echosounder and a broad band hydrophone. At the base of the VPS there is a long range ADCP to cover velocity structure throughout the water column as well as a near bottom CTD and bottom pressure recorder These observations expand the matrix of water column sampling in the northeast Pacific to provide long-term and high-temporal resolution with the capability of adaptive response to episodic events.

3B6.5 ID:5115 INVITED/INVITÉ 11:30

Three-dimensional Simulations of Shear Instabilities in Internal Solitary Waves

Kevin Lamb , *Christopher Subich*
University of Waterloo
Contact: kglamb@uwaterloo.ca

Recent observations and simulations of internal solitary-like waves on the Oregon Shelf [Lamb and Farmer, 2010] have shown the possibility for these waves to have shear-unstable regions which produce Kelvin-Helmholtz billows in the pycnocline. This work presents the results of numerical simulations conducted with a three-dimensional pseudospectral method. These three-dimensional simulations suggest that the generated billows three-dimensionalize in the tail of the internal waves and hence two-dimensional simulations can accurately predict the rate energy is transferred from the solitary wave to the Kelvin-Helmholtz billows.

1C1.1 ID:5116 INVITED/INVITÉ 14:00

Observations of Microphysical Processes at the Vancouver 2010 Winter Olympic Games

Paul Joe [1], *George Isaac* [1], *Ismail Gultepe* [1], *Stewart Cober* [1], *Ron Stewart* [2], *Alex Laplante* [3], *Julie Theriault* [4], *Paul Kucera* [4]
[1] Science and Technology Branch
[2] U of Manitoba
[3] McGill University
[4] NCAR
Contact: paul.joe@ec.gc.ca

The Vancouver 2010 Winter Olympic Games were conducted in February and March 2010. The variety of precipitation processes were examined via remote sensing and in-situ observations. A single winter season of vertical profile of reflectivities showed that evaporation and sublimation process resulted in virga (no precipitation at the valley floor) about 30% of the time. Precipitation could result from deep or very shallow systems. Remarkably, precipitation of an intensity of about 25 dBZ could result from very shallow precipitation initiated below mountain crest height (~2km). Melting occurred in a very narrow band which indicates the role of up/down slope flows along the mountain in the evolution of the precipitation. Observations from in-situ particle size sensors (POSS and Parsivel) and Doppler spectra from the vertically pointing micro rain radar provided fall speed and size information that are interpreted as growth by deposition but also riming. These were compared with observations of particle habits by imaging technology and/or micro-photography. Also, the vertical profiles of reflectivity and Doppler radial wind fields revealed a complex multi-layered atmosphere where deposition-sublimation and other precipitaton processes (e.g. aggregation) occurred several times in the vertical.

2D4.5 ID:5117 17:15

Energetics of Internal Solitary Waves in a Background Sheared Current: the Important role of Topography and a Free Surface

Kevin Lamb
University of Waterloo
Contact: kglamb@uwaterloo.ca

The energetics of internal waves in the presence of a background sheared current is explored via numerical simulations for four different situations based on oceanographic conditions: the nonlinear interaction of two internal solitary waves; an internal solitary wave shoaling through a turning point; internal solitary wave reflection from a sloping boundary and a deep-water internal seiche trapped in a deep basin. In the simulations with variable water depth using the Boussinesq approximation the combination of a background sheared current, bathymetry and a rigid lid results in a change in the total energy of the system due to the work done by a pressure change that is established across the domain. In non-Boussinesq simulations with a diffuse free surface the establishment of this pressure change is eliminated. Energy is now conserved, with the difference between the rigid-lid and free-surface simulations being accounted for by the generation of surface waves.

1B0.2 ID:5118 INVITED/INVITÉ 11:30

Spatiotemporal source apportionment of policy-relevant metrics

Amir Hakami , *Amanda Pappin* , *Morteza Mesbah* , *Nicole Macdonald*
Carleton University
Contact: amir_hakami@carleton.ca

Source apportionment studies have traditionally focused on finding contributions to concentrations at specific receptors. Also, these studies have usually relied on statistical approaches that correlate observed concentrations with emission source profiles and characteristics without consideration for physico-chemical transformations that occur as pollutants are transported from sources to receptors. More recent approaches such as the adjoint or backward sensitivity analyses allow for simultaneous calculation of contributions to a concentration- based metric from numerous individual sources. The adjoint of USEPA's Community Multiscale Air Quality (CMAQ) model is used to evaluate impact from various sources on metrics such ozone mortality and the Air Quality Health Index (AQHI). Sensitivities of these metrics in Canada with respect to emissions at various locations and times are calculated. Spatial and temporal distinctions in effectiveness of emissions in producing ozone will be explored and policy implications of these distinctions are discussed. Specifically we will try to address the following three questions: 1) what are the main contributing sources to air pollution mortality and AQHI on a nationwide basis? 2) How do emissions in various times of the day vary in terms of their contributions to air pollution mortality and AQHI? 3) How can these spatiotemporal distinctions in contributions to mortality and AQHI be exploited in a science-based air pollution decision support system?

1C0.5 ID:5119 15:15

Creating Actionable Air Quality Data using RDF (Resource Description Framework)

James Freemantle [1], *Norm O'Neill* [1], *Ian Lumb* [2], *Jack Mcconnell* [2], *Alex Lupu* [2], *Ihab Abboud* [3], *Bruce Mcarthur* [4]
[1] University of Sherbrooke, Quebec
[2] York University, Ontario
[3] Environment Canada, Sask.
[4] Environment Canada, Ontario
Contact: james.freemantle@rogers.com

The AEROCAN sunphotometery network generates optical indicators of aerosol concentration and size on a regional and national scale from over a dozen sites across Canada. These aerosol column measurements (along with other types of aerosol observations) and gaseous pollution measurements

can be employed to constrain air quality assimilation models and subsequently extrapolate the aerosol and gaseous properties in time and space. The resulting 4D grid of physical properties can then be transformed into surface maps of air quality and health indicators such as the AQHI (Air Quality Health Index). As part of the AEROCAN operational quality assurance (QA) methodology we have written automatic procedures to make some of the AEROCAN data more accessible or “actionable”. By actionable data we mean information that is presented in manner that can be understood and then used in the decision making process. The decision may be that of a technical professional, a policy maker, the lay public or a machine. We have been using RDF (Resource Description Framework) to enhance the utility of our sunphotometer data; the resulting self-describing representation is structured so that it is machine readable. This allows database like queries (e.g., via SPARQL) on our dataset that in the past were only viewable as passive Web tables of data. In addition encoding the observations and associated sensor metadata using the Sensor Web Enablement (SWE) Common Data Model allows sensor related data to be shared across applications. Efforts have been made to enable the dataset to become “Linked Data” further enhancing its value.

3B4.3 ID:5120 11:30

Impact of the model bias on water mass properties and circulation in eddy-permitting simulations of the subpolar North Atlantic

Entcho Demirov [1], *Jieshun Zhu* [2], *Frederic Dupont* [3]
[1] Department of Physics and Physical Oceanography, Memorial University of Newfoundland
[2] Department of Physics and Physical Ocenaography, Memorial University of Newfoundland
[3] Department of Physical Oceanography, Dalhousie University
Contact: entcho@mun.ca

The talk will present results from a study of the impact of model bias on the simulated water mass and circulation characteristics in an eddy-permitting model of the sub-polar ocean. We compare eddy-permitting prognostic model simulations with the results from two other runs in which the bias is constrained by using spectral nudging. In the first run, the temperature and salinity are nudged towards climatology in the whole column. In the second run the spectral nudging is applied in the surface 30m layer and at depths below 650m only. The drift of the model characteristics of the unconstrained run are similar to those reported in previous eddy-permitting and eddy-resolving studies. The salinity in the surface and intermediate waters of the Labrador Sea waters increases with respect to the climatology, which reduces the stability of the water column. The deep convection in the unconstrained run is artificially intensified and the transport in the sub-polar gyre stronger than in the observations. In particular the transport of relatively salty and warm Irminger waters into the Labrador Sea is unrealistically strong. While the water mass temperature and salinity in the run with spectral nudging in the whole column are closest to the observations, the depth of the winter convection is underestimated. The water mass characteristics and water transport in the run with spectral nudging in the surface and deep layers only are close to observations and at the same represent well the deep convection in terms of its intensity and position.

4D5.4 ID:5121 16:30

Quantifying Loss Terms in a Fjord Mesozooplankton Community: Advection and Mortality

Desiree Tommasi , *Brian Hunt* , *Evgeny Pakhomov*
University of British Columbia
Contact: dtommasi@eos.ubc.ca

Advection is one environmental factor that can influence mesozooplankton loss patterns in coastal waters. However, most studies of mesozooplankton population dynamics either assume advection is unimportant in their system, or simply incorporate it as part of a general mortality term that includes losses driven by both biology (e.g. predation) and physics (e.g. advection). If we are to determine causative agents of mortality, it is important to first quantify the variability in loss rates that is caused by fluctuations in advection. To assess the importance of advection effects on mesozooplankton in Rivers Inlet, a fjord in central British Columbia, flow velocity depth profiles and depth resolved mesozooplankton abundance data were utilized to determine specific advection rates for each mesozooplankton species and developmental stage. Flow velocities were obtained from a hydrodynamic model of Rivers Inlet, while bongo net hauls were conducted monthly from March to June 2010 at the surface, 10, 30, 100 and 300 m to assess mesozooplankton vertical distribution. Furthermore, the fine scale distribution of smaller species and stages was examined by collecting mesozooplankton samples with a Niskin bottle every meter for the first 10 m. Advection losses were found to be insignificant for adult individuals of species, such as Metridia pacifica, that undergo diel vertical migration and spend the majority of their day below the surface layer. However, advection was shown to be an important loss factor for taxa and stages, such as cladocerans or copepod nauplii that inhabit the fast flowing, brackish, surface layer of fjords. It is shown that seasonal and interannual changes in flow velocities can have a large effect on mesozooplankton population dynamics.

3C3.6 ID:5122 14:45

Modelling the future climate of the Gulf of St. Lawrence and Scotian Shelf; an application to snow crab habitat.

Joël Chassé [1], *William Perrie* [2], *Zhenxia Long* [2], *Dave Brickman* [2], *Lanli Guo* [2], *Mikio Moriyasu* [1]
[1] Gulf Fisheries Centre, Fisheries and Oceans Canada
[2] Bedford Institute of Oceanography, Fisheries and Oceans Canada
Contact: joel.chasse@dfo-mpo.gc.ca

Impacts of climate change on the bottom ocean properties in the Gulf of St. Lawrence and Scotian Shelf (GSL-SS) are not trivial to understand. Typically the Cold Intermediate Layer (CIL) is formed during the winter and is thereafter caped by freshwater and surface heating during spring and summer. The rate of erosion depends on the stability of the water column which is influenced by both freshwater and surface heat flux. For most years, the CIL is thick enough and touches the bottom in many areas, allowing for a suitable habitat of snow crab (Chionoecetes opilio) which is a cold water species. However recent observations have shown that conditions that are suitable for the snow crab are at their lowest, over a 30 year time series in the Southern Gulf of St. Lawrence. This has raised concerns about the future of one of the most lucrative fisheries in Eastern Canada. Using a regional ocean climate dynamical downscaling system developed within DFO, we investigate the future change of bottom temperatures in the GSL-SS system and we calculate the future habitat for snow crab up to 2069. Using past observed habitat carrying capacity, we estimate potential future changes to the snow crab population in the southern Gulf of St. Lawrence.

2D2.1 ID:5123 16:00

WMO intercomparison of instruments and configurations for measuring solid preciptiation

Rodica Nitu
Environment Canada
Contact: rodica.nitu@ec.gc.ca

Given the widely documented limitations of accurately measuring solid preciptiation and the increasing complexity of data needs of the user community, The World Meteorological Organization (WMO) has decided to coordinate the organization of a field intercomparison of automatic precipitation gauges and their configurations, in various climate conditions. This will be building on the significant efforts currently underway in many countries. The following objectives are proposed • improve the understanding of the performance of solid precipitation gauges/wind shield configurations. • Develop transfer functions between the various solid precipitation gauge and windshield configurations to improve estimates of liquid water equivalent snowfall in support of real-time performance, hydrological models and data continuity in climate record. • Define field standard for automated solid precipitation gauges. • Develop algorithms to derive parameters relevant for the measurement of solid precipitation. • Develop guidance on the accuracy and temporal resolution of solid preciptiation parameters Canada has assumed a leadership role coordinating a team of seven participating countries. The intercomparison is scheduled to start in 2011 and will take place over several years, on multiple sites, at least one in Canada.

1B4.1 ID:5124 INVITED/INVITÉ 11:00

Development of a coupled ice-ocean modelling system for Hamilton Inlet (Newfoundland and Labrador).

Joël Chassé [1], *Jason Chaffey* [2], *Maud Guarracino* [2], *Simon Prinsenberg* [2]
[1] Gulf Fisheries Centre, Fisheries and Oceans Canada
[2] Bedford Institute of Oceanography, Fisheries and Oceans Canada
Contact: joel.chasse@dfo-mpo.gc.ca

Hamilton Inlet, encompassing Groswater Bay, Melville Lake and Goose Bay, is a salty water inland system connected to the Labrador Shelf and influenced by freshwater runoff, tides and atmospheric forcing. Historical salinity-temperature profiles and ADCP measurements have revealed an estuarine-fjord like circulation system with fresher water outflowing at the surface. In such an estuarine system, the two-layer circulation is maintained by a delicate balance between freshwater runoff and mixing. Changes in the intensity of the freshwater discharge and/or its timing have influence on the physics of the system, including the stability of the water column, estuarine circulation, flushing rate and ice related processes. We will present the result of an application of a series of numerical models of the Inlet, ranging from finite element techniques to a full 3D prognostic application of the NEMO-OPA model. The latter is used to quantify the effect of changes in freshwater runoff on the physical properties of the inlet.

3P307.1 ID:5125 15:30

Response of the Subpolar North Atlantic to persistent NAO-like forcing

Hakase Hayashida , *Entcho Demirov* , *Jieshun Zhu*
Department of Physics and Physical Oceanography, Memorial University of Newfoundland
Contact: entcho@mun.ca

The response of the Subpolar North Atlantic (SPNA) to the North Atlantic Oscillation (NAO) is studied with an ocean general circulation model (NEMO). Two model experiments are conducted that are forced with surface forcing typical for positive and negative phases of the NAO. The intensity of SPG circulation and temperature of sea surface and intermediate waters under persistent NAO-like forcing are studied. The results suggest that the response of the SPNA to the NAO is asymmetric with strong quasi-decadal variations in the positive NAO run. The amplitude of decadal variability is

smaller or not present under negative NAO forcing. The model results are used to explain recently observed variability of the SPNA in the 1980s and 1990s.

3B2.1 ID:5126 INVITED/INVITÉ 10:30

Crop evapotranspiration impacts on drought and convective environments

G.s. Strong [1], *C.d. Smith* [2], *Danny Brown* [1], *William Henson* [3]
[1] Earth and Atmospheric Sciences, University of Alberta
[2] Climate Research Division, Environment Canada
[3] University of McGill
Contact: craig.smith@ec.gc.ca

Two years (2009/10) of data on evapotranspiration and moisture profiles over canola, barley, and pasture grass from the KEEFEX Environment Canada study site near Kenaston SK are presented. Analysis includes 2009 comparative spot moisture profiles over canola near Edmonton AB. Results are discussed for 2009 drought conditions and for 2010 high soil moisture capacity cases.

Surface transects of temperature and moisture conducted across Edmonton during 2009 are also reviewed to examine moisture gradients between cropped areas and the urban dry island over downtown city cores. The Edmonton dry island is scrutinized in terms of its effect on regional precipitation and potential downstream effects on a drought area east of Edmonton, using both diagnostic radar data and predictive results from WRF model runs. This work was partly funded by Environment Canada and the CFCAS Drought Research Initiative (DRI).

1B1.5 ID:5127 12:15

Gravity wave reflection and its associated triggering of locally heavy precipitation during SNOW-V10

Melinda Brugman [1], *Heather Reeves* [2], *Paul Joe* [3], *George Isaac* [3], *Ruping Mo* [1], *Jason Mibrandt* [4], *Bertrand Denis* [4]
[1] National Lab for Coastal and Mountain Meteorology, MSC, Environment Canada, Vancouver, BC, Canada
[2] NOAA/NSSL, Norman, OK , USA
[3] Cloud Physics and Severe Weather Research Section, Environment Canada, Toronto, Ontario, Canada
[4] Recherche en prévision numérique, Environment Canada, Dorval, Québec, Canada
Contact: mindy.brugman@ec.gc.ca

During Snow-V10, gravity waves were detected interacting with the complex terrain of the Pacific Northwest. Two such cases (16 and 24 February 2010) are examined herein via consideration of available observations and high-resolution numerical model output. In the first case, the gravity waves appear to “bounce” off Mt Baker and then propagate back upstream to later trigger convective clouds and precipitation in the northern Puget Sound convergence zone (generally northeast of the Olympic Mountains near Whidbey Island). In the latter case, the waves appear to be generated offshore and move toward the east. In either case, cloud-wave trains are generated, leading to locally enhanced precipitation. Changes in the precipitation type, in particular a fluctuation between dry crystals and heavy, wet aggregates, are also observed at some altitudes. These changes are particularly well captured in dual-polarized radar measurements taken during the events. Consideration of numerical model output shows that the Olympic 1-km LAM performed remarkably well by capturing of the cloud and precipitation patterns, but did not resolve all the features associated with large gravity waves.

3P307.2 ID:5128 15:30

Model study of the mesoscale variability in the western part of Labrador Sea

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

The talk presents results from eddy-resolving simulations of the Labrador Sea. The ocean model is NEMO with 1/12 degrees of resolution, which is forced with monthly mean NCEP/NCAR atmospheric forcing. The sources of mean available potential and kinetic energy and the rates of their conversion towards energy of mesoscale eddies are assessed. The spatial and seasonal variability of model energetics and their relation to variability of the surface forcing and topographic effects are discussed.

3B6.3 ID:5129 11:00

Laboratory investigation of three modes of instability in a stratified shear flow

Edmund Tedford [1], *Jeffrey Carpenter* [2], *Roger Pieters* [3], *Greg Lawrence* [3]
[1] University of California, Santa Barbara
[2] EAWAG
[3] University of British Columbia
Contact: ttedford@eos.ubc.ca

Instabilities were investigated in a new exchange flow facility at the University of British Columbia. The exchange flow was setup in a tube of rectangular cross section that was connected to a freshwater reservoir at one end and a salt water reservoir at the other end. The new facility allows the tube (and the exchange flow within) to be tilted with minimal disturbance to the two reservoirs. When the tube is horizontal, a steady two-layer exchange flow occurs that supports symmetric leftward and rightward propagating instabilities. The behaviour and appearance of these instabilities matches previous laboratory and numerical examples of Holmboe’s instability. When the tube is tilted, as in common closed tube experiments, shear increases and Kelvin-Helmholtz (KH) instabilities are generated. These instabilities break down the sharp density interface resulting in a broad region of mixing. Subsequent leveling of the tube results in a three-layer exchange flow. The upper and lower layers are nearly pure fresh and salt water respectively. Separating these two layers is a relatively thin layer of nearly homogeneous mixed fluid generated by the Kelvin-Helmholtz instabilities. Within this layer instabilities form that resemble the cats-eye predicted by Taylor. This intermediate layer gradually erodes leaving two layers with Holmboe instabilities at the interface. The response of the exchange flow to tilting and the resulting instabilities are described with particle image velocimetry, laser induced florescence and particle streaks.

2C5.1 ID:5130 INVITED/INVITÉ 14:00

Overview of the synthesis papers produced by SCOR working group 128 on coastal hypoxia (2005-2010)

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

In the fall of 2005, the Scientific Committee on Oceanic Research (SCOR) approved the creation of working group 128 on “Natural and human-induced hypoxia and consequences for coastal areas”. After two consultation and planning meetings in 2006 and 2007 involving all members of the working group, smaller teams of co-authors began putting together 10 synthesis papers on the state-of-the-science of coastal hypoxia. These papers, published in 2009-2010, dealt with topics such as the impacts of hypoxia on sediment biogeochemistry, benthic fauna, pelagic species, and water column biogeochemistry including potential feedbacks to the climate system through enhanced production of nitrous oxide from shallow hypoxic zones. Other papers dealt with modeling, estimating global oxygen trends, and examining how coastal hypoxic systems respond to restoration measures. A summary of the key findings from these papers will be presented.

3P206.1 ID:5131 15:30

Snow Comparison of Observed to Model Amounts during Snow-V10

Mindy Brugman [1], *Paul Joe* [2], *George Isaac* [2], *Jason Millbrandt* [3], *Ismail Gultepe* [2], *Faisal Boudala* [2], *Roy Rasmussen* [4], *Paul Kucera* [4], *Julie Theriault* [4], *Mark Barton* [5], *Jim Goosen* [6], *Chris Doyle* [7]

[1] Coastal and Mountain Meteorology Lab, Meteorological Services of Canada, Environment Canada
[2] Cloud Physics and Severe Weather Research Section, Environment Canada, Toronto, Ontario, Canada
[3] Recherche en prévision numérique, Environment Canada, Dorval, Québec, Canada
[4] National Center for Atmospheric Research, Boulder, Colorado, USA
[5] MOC, MSC, Environment Canada, Richmond, British Columbia, Canada
[6] Pacific Storm Prediction Centre, Environment Canada, Vancouver, British Columbia, Canada
[7] Science Division and CMML, MSC, Environment, Canada, Vancouver, British Col
Contact: mindy.brugman@ec.gc.ca

The goal of this project is to process observed snowfall data so it can be compared to model data for Snow-V10. Snowfall amounts derived from observations are typically not comparable with output obtained from high resolution numerical models. The snowfall amounts are collected or derived differently. Fore example, they are sampled over different temporal and spatial scales. A variety of other issues make comparisons difficult such as problems with instrument calibration. Moreover, there are processes that occur between the time steps of measurement that can affect observations. The snowfall observations from Snow-V10 have been reprocessed and compared to model results. Focus is placed on analysis of snow depth and density (i.e. snow/water ratio) data obtained from surface and remote sensing methods for Snow-V10. Precipitation type, temperature, humidity, winds, visibility and other weather parameters will be considered to better understand the controlling processes and to help improve forecasting. This study will begin in the Whistler area where a robust and high quality data set was obtained during Snow-V10. A consistent relationship between forecast and observed snow density and snow amounts are developed starting at the VOA (“Pig Alley”) site. All the Olympic 2010 sites where heavy snowfall events occurred during the Snow-V10 study period (2005-2010) will be examined in this study with emphasis on the final year when the instrumentation was complete. This study is aimed to improve our understanding of snowfall processes and our ability to model these processes accurately in mountain environments. Proper multi-sensor verification of snow amount is essential for improved forecasts and model development.

3B3.2 ID:5132 10:45

Early steps in the establishment of a global oxygen observing system prompted by climate change scenarios of ocean deoxygenation.

Denis Gilbert

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

Starting with the first results in 1998 of a global ocean biogeochemical model embedded within a coupled atmosphere-ocean climate model, the ocean modeling community has consistently predicted that the inventory of dissolved oxygen in the ocean will likely decrease at a rate 3 to 4 times faster than what we might expect from temperature-driven changes in oxygen solubility. Meanwhile, technological improvements in electrolyte-based as well as optical-based oxygen sensors have lead to better oxygen measurement accuracy, reproducibility and calibration stability. All of these ingredients motivated the conduct of a few pilot studies to equip a subset of robotic Argo profiling floats with oxygen sensors. Progress accomplished and setbacks suffered during these pilot Argo-O2 studies will be summarized.

1C1.4 ID:5133 15:00

Heavy Snowfall Occurred as Ozone Wrapped Beneath Warm Moist Conveyors during Snow-V10

Mindy Brugman [1], *Paul Joe* [2], *Jason Milbrandt* [3], *Anne Marie Macdonald* [4], *George Isaac* [2], *Ruping Mo* [1]
[1] National Lab for Coastal and Mountain Meteorology , MSC, Environment Canada, Vancouver, BC, Canada
[2] Cloud Physics and Severe Weather Research Section, Environment Canada, Toronto, Ontario, Canada
[3] Recherche en prévision numérique, Environment Canada, Dorval, Quebec, Canada
[4] Air Quality Research Division, MSC, Environment Canada, Toronto, Ontario, Canada
Contact: mindy.brugman@ec.gc.ca

The prediction of heavy snowfall is improved by better understanding storm structure and its impact on cloud microphysics during the Vancouver 2010 Winter Olympics. This is an investigation into the dynamics of the flow reversal phenomena that is hypothesized to be associated with heavy snowfall observed during the Snow-V10 project. In this study the tracer ozone was found in an unexpected location within the cold conveyor belt identified by an elevated dry (and weak echo) flow reversal layer. This ozone was wrapped counterclockwise beneath the warm front ahead of an intense mid-latitude lower pressure system approaching British Columbia Coastline on March 12, 2010. Only one previous study could be found with a similar feature (Aircraft Measurements of a Warm Conveyor Belt – A Case Study, by G. Vaughan et. al, University of Wales, JAC, 2006), but was reported as anomalous and unexplained. The lead authors confirmed they had no reason to exclude the “anomalous” ozone observations, and their results appeared similar to the “anomalous” ozone found in the warm advection region (ahead of the surface warm front and TROWAL) during Snow-V10. In this study we will refer to this zone as the Cold Conveyor Flow Reversal Ozone (CCFRO) zone. The storm structure and thermodynamics of strong low pressure systems for this study were examined using the observational and modeling network established for the SNOW-V10 WMO WWRP program carried out during the Vancouver 2010 Winter Olympics. The role of Stratospheric-Tropospheric Exchange (STE) and folding is examined using ozone data obtained from summit of Whistler peak (2200 m asl) using data provided by co-author Anne Marie MacDonald, MSC, Air Quality Research, Downsview. Possible mechanisms are discussed to provide insight into how the storm may have captured and inserted this natural ozone beneath the warm sector (ahead of the TROWAL) and why the ozone appears associated with a dry (weak echo) flow reversal. The upper flow reversal detected during Snow-V10 appears distinctly separate from the moist low level flow reversal shown to be related to diabatic effects during heavy precipitation into a falling snow level (see Theriault et al, CMOS, 2011) This distinctive CCFRO zone was first identified using the Olympic Whistler C band Doppler radar to detect elevated bright bands. The upper bright band above mountain top was found associated with a southerly warm conveyor belt that streamed moisture slantwise upwards ahead of the surface warm front and/or TROWAL. The upper bright band was underlain by

the CCFRO identified by weak radar echo regions showing a unique pattern of a counterclockwise rotating weak echo flow reversal, located above the snow level. A repeatable sequence developed in the coastal mountains near Whistler and nearby areas with each major storm demonstrated by radar reflections, wind flow, ozone concentration, snow level and heavy precipitation patterns. A unique “camel-back” trend in the ozone concentration was observed for each major storm, and may be explained in terms of conveyor belt theory (warm, cold and dry belts) and mid-latitude storm structure. Results are compared to high resolution modeling using the CMC Olympic 1 and 2.5 km models and are aimed to provide better forecasting of heavy precipitation and related snow levels over the mountains of western Canada.

3P407.5 ID:5134 15:30

Modelling shifts in seawater $\delta^{18}O$ due to glacial-interglacial sea ice variability

Catherine Brennan [1], *Andrew Weaver* [1], *Michael Eby* [1], *Katrin Meissner* [2]
[1] University of Victoria
[2] University of New South Wales
Contact: cbrennan@ocean.seos.uvic.ca

The oxygen isotope composition of seawater has varied through earth history, mainly based on the amount of (depleted) ice stored on continents. $\delta^{18}O$ records derived from ocean sediment cores constitute an important paleoproxy of past ocean conditions, serving as indicators of temperature and ice volume, for example. $\delta^{18}O$ records, especially at high latitudes, may carry the imprint of variability in sea ice production. Sea ice growth produces isotopically enriched sea ice and depleted brine (by 3 permil at equilibrium). Over glacial-interglacial cycles, changes in sea ice production (and by extension in sea ice meltwater and brine export) hold the potential to alter seawater isotopic chemistry, thereby superimposing an unacknowledged error to interpretations of high latitude $\delta^{18}O$ records.

Here we examine the effects of variability in sea ice production between glacial and interglacial climate states on seawater $\delta^{18}O$ in a coupled climate model. Oxygen isotopes have been implemented in all components (ocean, atmosphere, land surface, and sea ice) of the University of Victoria Earth System Climate Model. The role of glacial-interglacial sea ice variability is investigated in a set of model experiments. First, the model is integrated to equilibrium for both glacial and interglacial climate states. For each climate state, two simulations are performed, identical except that oxygen isotope fractionation during sea ice formation is turned on and off. The difference between these simulations provides the modeled seawater $\delta^{18}O$ field due only to sea ice formation. By contrasting the seawater $\delta^{18}O$ fields due to sea ice formation resulting from the glacial and interglacial climates, the potential for variable sea ice formation shifting deepwater $\delta^{18}O$ is investigated.

4D2.5 ID:5135 INVITED/INVITÉ 16:30

No validation, but consistency

Gerd Buerger
PCIC
Contact: gbuerger@uvic.ca

The ideal testbed for the problems addressed by this session is a physically consistent, high-resolution climate scenario, sometimes dubbed 'surrogate climate', where all downscaling methods could be

explored and validated in arbitrary detail. This testbed is of course not available in any foreseeable future.

Instead of validating downscaling methods against this ideal, nonexisting background, I propose here to "validate" existing downscaling methods against each other. Under certain circumstances it is possible to use the high-resolution local scenario of one downscaling method A, along with the global driving fields, as a surrogate climate for another method B. B can be trained on the present climate data of A, and fully "verified" against the future data of A. Or vice versa, that is, swapping present and future. In fully equivalent cases one may even swap method A and B.

For example, one can use the daily global and downscaled local scenarios produced by SDSM (Statistical DownScaling Model) or EDS (Expanded Downscaling) as method A, and calibrate and validate TreeGen as method B using these data.

Another method B that I am planning to test is the "quantile mapping" approach. Here one identifies local and global/regional quantiles of equal corresponding probability. Under this assumption, a future return period of some local extreme event can be derived directly from the future return period of the corresponding global/regional quantile.

Of course, no method A will ever be the ideal testbed for validating B, but testing B using A gives at least an idea of consistency between A and B.

1C6.2 ID:5136 14:15

Ontario Ministry of Transportation (MTO) phase 2 progress

Ric Soulis [1], *Muhammad Naeem* [2]
[1] Civil and Environmental Engineering, University of Waterloo
[2] Ontario Ministry of Transportation
Contact: rsoulis@uwaterloo.ca

The Ontario Ministry of Transportation (MTO) study to interpolate the MSC IDF curve station data for use throughout Ontario is in progress. This presentation will present the results from the 2004-2005 data as well as data from surrounding political jurisdictions. Some discussion of the investigation of the impact of climate change will be included.

2B1.4 ID:5137 11:30

Reanalysis of a band of heavy rain and strong wind across the Inner South Coast of British Columbia

Ruping Mo [1], *Cindy Yu* [2], *Johnson Zhong* [2], *Ken Kwok* [2]
[1] National Laboratory for Coastal & Mountain Meteorology, MSC, EC, Vancouver, BC V6C 3S5
[2] Pacific Storm Prediction Centre, MSC, EC, Vancouver, BC V6C 3S5
Contact: Ruping.Mo@ec.gc.ca

A narrow band of heavy rain and strong wind moved across the Inner South Coast of British Columbia (BC) in the afternoon of 19 May 2010, resulting in widespread power outages and property damages. Such an intense mesoscale system is very difficult to forecast over the complex terrain of coastal BC. In this study, we perform a detailed reanalysis of this storm based on intensive observations and high-resolution numerical weather prediction (NWP) model outputs available mainly from Environment

Canada and the SNOW-V10 Project.

Our analysis indicates that this banded precipitation was induced by a trowal (trough of warm air aloft) ahead of a rapidly deepening cyclone offshore. Radar observations were capable of detecting the early signal of the rain band off the Washington Coast and the following orographic enhancement over the Vancouver Island Ranges. With the support of wrapped-around moisture from a warm conveyor belt, the rain band redeveloped over the Strait of Georgia and moved onshore with the trowal. It was the strong downburst from rain-cooled air that caused the damaged winds in the wake of the heavy banded rain.

This intense mesoscale system was reasonably well forecast by the high-resolution, limited-area NWP models of Environment Canada, which have the power to resolve some detailed interactions of air flow with the local topography. It is shown that the initial and boundary conditions fed by the lower-resolution model may also affect the forecast accuracy of the high-resolution models. A combination of the model guidance with the radar observations and a conceptual model of the trowal airstream could lead to a successful nowcasting of the system.

1P705.1 ID:5139 16:00

Technical Challenges of the XM Tool Project: A Comparison of Statistical Post-Processing Methods in Support of the Canadian Air Quality Health Index Forecast Program

Sean Perry , *Andrew Teakles*
Environment Canada
Contact: sean.perry@ec.gc.ca

In the fall of 2009, the XM tool project was initiated to explore the use of non-linear statistical methods. The project endeavours to extend the capabilities of UMOS and optimize the current AQHI forecast program. Apart from improving overall model performance, a particular focus was placed on both improving guidance for air quality episodes and identifying the start and end of an air quality episode.

The XM tool project is a collaborative effort made possible by Environment Canada developers from various regions. A project framework was established to allow developers to rapidly prototype different post-processing methods. By comparing the proposed statistical models' strengths and weaknesses, the effectiveness of these models can be evaluated based on the projects well defined performance criteria. This is accomplished by using identical verification routines.

The following presentation illustrates the technical challenges behind the XM tool project. This presentation will cover methods of data sampling, an analysis of different predictor selection approaches, and a technical comparison of the various post-processing methods. The effect of using antecedent predictors will also be analyzed.

1B6.1 ID:5140 11:00

Projections of climate change extremes in British Columbia

Trevor Murdock , *Gerd Burger*
Pacific Climate Impacts Consortium
Contact: tmurdock@uvic.ca

Demand for projections of extremes has arisen out of local infrastructure vulnerability assessments and adaptation planning. Several preliminary analyses of extremes have been undertaken at Pacific Climate Impacts Consortium in collaboration with users (BC Ministry of Transportation and Infrastructure, Engineers Canada, City of Castelgar, and Columbia Basin Trust) in British Columbia over the past 18 months. Projects have included analysis of extremes for stormwater management, highways, and community adaptation and have spanned the province from the coast near Hope to north of Prince George to the Columbia Basin. Methods used to provide projected changes in extremes based on Regional Climate Model simulations as well as statistical downscaling will be described. In particular, the need for threshold scaling, use of the Generalized Extreme Value theorem for return periods of rare events, and the need to use as large of an ensemble as possible will be discussed.

3C6.2 ID:5141 13:45

Comparison and validation of South Asian monsoon rainfall simulations using Community Climate System Models

Siraj Ul Islam , *Youmin Tang*
University of Northern British Columbia
Contact: sislam@unbc.ca

Asian monsoon is an important component of the global climate system, and has critical influence on the weather and climate anomalies on the global and local scales. It has been a challenge in modeling and predicting Asian monsoon using atmospheric or climate models. This study examines in details the ability of several versions of Community Climate System Model (CCSM) in simulating the South Asian Monsoon. These models include Community Atmosphere Model version 4 (CAM4) and 5 (CAM4) as well as atmospheric ocean coupled model CCSM4. CAM4 and CAM5 simulations forced with observed sea surface temperatures (SSTs) are validated against observation. Comparisons among these versions reveals the relative importance of different physic process and model parameters in simulating the South Asian Monsoon. For coupled model i.e. CCSM4, SVD analysis are performed to analyze coupled patterns of air-sea interaction. These modes are then compared with their corresponding observed patterns.

4D0.6 ID:5142 INVITED/INVITÉ 16:45

Future CO2 emissions and climate change from existing energy infrastructure

Steven Davis [1], *Ken Caldeira* [1], *Damon Matthews* [2]
[1] Carnegie Institution of Washington
[2] Concordia University
Contact: sjdavis@carnegie.stanford.edu

Slowing climate change requires overcoming inertia in political, technological, and geophysical systems. Of these, only geophysical warming commitment has been quantified. We estimated the commitment to future emissions and warming represented by existing carbon dioxide–emitting devices. We calculated cumulative future emissions of 496 (282 to 701 in lower and upper bounding scenarios) gigatonnes of CO_2 from combustion of fossil fuels by existing infrastructure between 2010 and 2060, forcing mean warming of 1.3°C (1.1° to 1.4°C) above the pre-industrial era and atmospheric concentrations of CO_2 less than 430 parts per million. Because these conditions would likely avoid many key impacts of climate change, we conclude that sources of the most threatening emissions have yet to be built. However, CO2-emitting infrastructure will expand unless extraordinary efforts are undertaken to develop alternatives.

2B3.2 ID:5143 10:45

Improving AQHI forecasting by quantifying the spatial and temporal variation of PM2.5, NO2 and ground-level O3 in urban Halifax and rural Annapolis Valley, Nova Scotia, Canada

Mark Gibson [1], *David Waugh* [2], *Doug Steeves* [2], *Dave Henderson* [2], *Judy Guernsey* [1], *Matt Seaboyer* [1], *James Kuchta* [1], *Gavin King* [1], *Neil Brewster* [1], *Richard Gould* [3], *Dave Stieb* [4]
(Presented by *Gavin King*)
[1] Dalhousie University
[2] Environment Canada
[3] Nova Scotia, Health Promotion and Protection
[4] Health Canada
Contact: mark.gibson@dal.ca

Air Quality Health Index (AQHI) was developed as a risk communication tool intended to aid people in making informed choices to protect themselves from short-term health impacts of air pollution. The AQHI is calculated from the concentrations of fine respirable particles (PM2.5), nitrogen dioxide (NO2) and ground-level ozone (O3). The data for these three AQHI relevant air pollutants are collected from the Government National Air Pollution Surveillance (NAPS) Network. However, the limited number of NAPS sites restricts Environment Canada's ability to analyze the spatial and temporal behavior of pollutants in certain areas of Nova Scotia, which is required for forecasting the AQHI. The Government must use general assumptions about air shed concentrations and numerical models, e.g. GEM-MACH15 to fill in the gaps. In an effort to validate existing AQHI reporting and to better inform and validate AQHI forecasts, air quality and meteorological data collected throughout the Annapolis Valley (AV) and the Halifax region from January 2009 to May 2010 are being compared to AQHI data obtained from local NAPS sites (e.g. Aylesford Mountain-AV, Halifax & Dartmouth). Seasonal, temporal and spatial variations of the AQHI have been quantified and compared within and between regions. Empirical multivariate predictive models were developed using Aylesford Mountain NAPS site pollutant data and meteorological measurements to enhance air quality forecasting on the AV floor. Data analysis conducted over 21 weeks (11 March – 20 September, 2009) of PM2.5, NO2 and O3 data collected from Dalhousie University's ambient monitoring station in Middleton, AV have yielded an AQHI range of 0.08 to 5.2. We will determine and report on whether indeed there is a significant difference observed between AQHI values derived from the Aylesford Mountain NAPS site and those calculated from the AV floor measurements and the factors responsible for any significant difference, e.g. thermal inversions.

3P706.4 ID:5144 15:30

The sponge pump: the role of current induced flow in the design of the sponge body plan

Sally Leys [1], *Gitai Yahel* [2], *Matthew Reidenbach* [3], *Verena Tunnicliffe* [4], *Uri Shavit* [5], *Henry Reiswig* [6]
[1] Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9
[2] The School of Marine Sciences, Ruppin Academic Center, Michmoret , Israel
[3] Department of Environmental Sciences, University of Virginia, Virginia, USA
[4] Dept. Biology, University of Victoria, Victoria, BC
[5] Department of Civil and Environmental Engineering, Technion, Israel Institute of Technology, Israel

[6] Natural History Section, Royal British Columbia Museum, Victoria BC Canada
Contact: verenat@uvic.ca

Sponges are suspension feeders known to filter many times their body volume of water per hour actively, using flagellated collar-cells. Flow through sponges is thought to be enhanced by ambient current that induces a pressure gradient across the sponge wall by a process explained by Bernoulli's principle. Studies of sponge filtration have estimated the energetic cost of pumping to be < 1% of its total metabolism implying there is little adaptive value to reducing the cost of pumping by using "passive" flow. We quantified the pumping activity and respiration of the glass sponge *Aphrocallistes vastus* in situ at a 150 m deep reef and in a flow flume; we also modeled the glass sponge filtration system from measurements of the aquiferous system. Excurrent flow from the sponge osculum measured in situ and in the flume were positively correlated (r>0.75) with the square of the ambient current velocity, as suggested by the Bernoulli principle. During short bursts of high ambient current, the sponges filtered two-thirds of the total volume of water they processed daily. Our model indicates that the head loss (due to resistance) across the sponge collar filter is 10 times higher than previously estimated for demosponges. The difference is due to the resistance created by a fine protein mesh that lines the collar. These pumping rates give a conservative energetic expenditure of ~60 mJ (L pumped)$^{-1}$, at least 25% of the total in situ respiration. We suggest that because of the high cost of pumping, current induced flow is highly beneficial for tall, thin walled sponges living in high flow environments. The interaction between flow and energetic needs of these animals may explain the development of sponge reefs in isolated locations.

2D2.4 ID:5145 16:45

Precipitation Gauge Performance During High-Wind/High-Rate Snowfall Events

Scott Landolt [1], *John Kochendorfer* [2], *Roy Ramussen* [1]
[1] National Center for Atmospheric Research
[2] Climate Reference Network/NOAA
Contact: landolt@ucar.edu

It is well documented that precipitation gauges elevated above the ground and freely exposed to the wind, will collect less precipitation than gauges protected from the wind (Alter 1937; Goodison et al. 1989; Yang et al. 1998). Wind speeds of only a few meters per second can drastically decrease the amount of precipitation, particularly snow, collected by a gauge. The wind causes hydrometeors to blow over and around the gauge instead of falling into the gauge. Thus, wind speed corrections to precipitation accumulations must be applied to determine the actual precipitation amount. While transfer functions have been developed to correct for these wind errors, most of the data collected for these functions were collected with wind speeds less than ten meters per second. The Research Applications Lab (RAL) at the National Center for Atmospheric Research (NCAR) has maintained a network of precipitation gauges at the Marshall Field Site just outside of Boulder, Colorado for over 15 years. These gauges, primarily GEONOR T-200b gauges, have been installed in various types of gauge shielding including Alter shields, double Alter shields, and Double Fenced Intercomparison Reference (DFIR) shields. Although instances of high precipitation rates (>2 mm/hr) combined with high winds (> 10 m/s) are uncommon, the span of time during which the site has been operational has allowed for data collection during many of these events. A comparison of the gauge accumulations within the various windshields will be presented as well as the transfer functions.

2C0.4 ID:5146 14:45

Complementing DFO's monitoring programs with an operational ocean forecast and reanalysis system as part of CONCEPTS.

Melanie Cooke [1], *Jennifer Wells* [1], *Andry Ratsimandresy* [1], *Greg Smith* [2], *Jeff Laham* [1], *Eugene Colbourne* [1], *Fraser Davidson* [1]
[1] Fisheries and Oceans Canada
[2] Environment Canada
Contact: davidsonf@dfo-mpo.gc.ca

In Atlantic Canadian waters DFO collects in-situ oceanographic observations from fixed sites and along standard sections up to 3-times yearly as a part of the Atlantic Zone Monitoring Program. Spring and Fall fisheries assessment surveys provide sparse water column measurements along the shelf. Oceanographic measurements are also occasionally obtained from ships-of-opportunity and fishing vessels. These measurements provide detailed snapshots but cannot give full coverage of the region and can at best capture seasonal variability. We intend to enhance these observations by reproducing standard section current velocities and bottom temperatures using the C-NOOFS ocean forecasting implementation of the NEMO model. This work is part of DFO's contribution to the DFO-EC-DND MOU entitled CONCEPTS. By analyzing the comparison with observational data, we can assess and roughly correct the model output for use in biological, fisheries and Coast Guard applications.

2C0.6 ID:5147 15:15

Validation protocols for the CONCEPTS Regional and Global Ocean Forecast Systems

Fraser Davidson [1], *Melanie Cooke* [1], *Jennifer Wells* [1], *Greg Smith* [2], *Charles Hannah* [1], *Zeliang Wang* [1], *Jeff Laham* [1], *Andry Ratsimandresy* [1]
[1] Fisheries and Oceans Canada
[2] Environment Canada
Contact: davidsonf@dfo-mpo.gc.ca

In the development of coupled atmosphere ocean ice forecast systems under a DFO-EC-DND initiative entitled CONCEPTS (Canadian Operational Network of Coupled Environmental PredicTion Systems), there is a need to measure improvement made in reproducing and forecast ocean conditions. This talk focuses on recent developments in applying performance metrics to evaluate and understand the strength and weaknesses of the ocean forecasting and reanalysis system used within CONCEPTS. These metrics can be applied on the daily forecast systems as well as historical reconstructions of ocean conditions and are applicable to both the global and regional systems. The talk focuses on validation with both in-situ and remote sensed observations.

1C4.4 ID:5148 14:45

Validation of new environment Canada winds on search and rescue drift calculations

Jennifer Wells [1], *Melanie Cooke* [1], *Fraser Davidson* [1], *Greg Smith* [2], *Brian Stone* [3], *Ron Dawson* [3]
[1] Fisheries and Oceans Canada
[2] Environment Canada
[3] Canadian Coast Guard
Contact: davidsonf@dfo-mpo.gc.ca

In mid December 2010, DFO Science and the Canadian Coast Guard deployed 35 drifters on the Grand Banks to anchor a validation experiment for search and rescue drift calculations. The experiment was designed to validate the impact of assimilation of a new scatterometer data product

into the GEM Atmospheric Model. The new and old wind fields were used to drive two separate set's of ocean model runs using the C-NOOFS 10 day ocean forecast system on a daily basis over a 60 day period. A twin experiment was then realized where the drift calculations of the buoys were recreated using Coast Guard approved drift methodology with the two different wind fields. Results and protocols used in this twin validation drift experiment are presented and discussed

4A0.2 ID:5149 INVITED/INVITÉ 09:15

Towards IPCC AR5: The Physical Science Basis - Emerging Questions, Structure of the Report and Schedule

Thomas Stocker
Physics Institute, University of Bern, Switzerland
Contact: stocker@climate.unibe.ch

The Intergovernmental Panel of Climate Change (IPCC) has the task to "assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, [...] " in a way that is "neutral with respect to policy". In 2008 IPCC has decided to initiate a Fifth Assessment Report (AR5) which will be completed by the end of 2014. Working Group I (WGI) focuses on the Physical Science Basis and its contribution to AR5 is well underway. The scope has been developed and the author teams have been formed. From 977 nominations, WGI has selected 258 authors from 44 countries. As in the previous assessment, observations and reconstructions of climate change are a key component of the report: they are assessed in 4 of the 14 chapters. Several new features are included in AR5. Sea level change is now assessed in a dedicated chapter. AR5 takes a fresh approach to regional information which is crucial to estimate impacts of and adaptation to, climate change. A special chapter will deal with climate phenomena, such as monsoon, El Niño-Southern Oscillation and others, which are important factors for regional climate and climate change. The focus will be on assessing the understanding of these phenomena, their sensitivity to forcing and the changes in their characteristics in response to the increase of greenhouse gases. The regional information is completed by an "Atlas of Global and Regional Climate Projections" which presents information from multi-model ensemble simulations performed by the scientific community under the CMIP5 initiative. In order to ensure a transparent assessment process, deadlines for submission and acceptance of scientific contributions have been set. Only papers that have been formally accepted by that deadline will be assessed. More details are available from www.ipcc.unibe.ch .

3B4.1 ID:5150 INVITED/INVITÉ 10:30

Dan Wright's key contributions to the development of ocean climate models of intermediate complexity

Thomas Stocker
Physics Institute, University of Bern, Switzerland
Contact: stocker@climate.unibe.ch

More than 20 years after the publication of the McGill's Centre for Climate and Global Change Research Report 90-13, entitled "A zonally averaged ocean model for the thermohaline circulation", first-authored by Dan Wright, Earth System Models of Intermediate Complexity, or EMICs, now occupy a firm position in the hierarchy of climate models. Lawrence Mysak, my post-doctoral advisor and host, invited Dan to spend his sabbatical at the Department of Meteorology of McGill University in the first half of 1990. It was my luck that I then met Dan Wright, this sharp and inquisitive

theoretical physical oceanographer. Our common roots in shelf and topographic wave dynamics, and the shared desire to move on to the global scale, were the start of an intensive and stimulating collaboration which would last for ten years. Naturally, the first steps to establish a new type of climate model were hard and reviewers were tough with us. But the rigour, a hallmark of Dan's approach, paired with his mathematical skill lead to a well-founded parameterization of the east-west pressure gradient which is a key element of zonally averaged ocean circulation models. However, typical for Dan, he was not satisfied and developed a more consistent scheme by incorporating boundary layer dynamics. He showed that this new scheme was in excellent agreement with the relationships diagnosed from a comprehensive 3-dimensional ocean model. Dan took great pleasure in extending the 2-dimensional model to a global model with multiple basins, which was later referred to as a "2.5-dimensional" model. With this new tool a wide variety of problems in climate research could be tackled. Through his deep understanding of ocean dynamics, his mathematical rigor, and his generosity towards his colleagues, Dan has laid a solid and lasting foundation for climate modelling of intermediate complexity.

4C4.5 ID:5151 14:45

Decline and rebound of the Labrador Current over 1993-2004

Guoqi Han [1], *Kyoko Ohashi* [1], *Nancy Chen* [1], *Paul Myers* [2], *Nuno Nunes* [3], *Jurgen Fischer* [3]
[1] Fisheries and Oceans Canada
[2] University of Alberta
[3] Leibniz Institute of Marine Sciences
Contact: Guoqi.Han@dfo-mpo.gc.ca

Monitoring and understanding of Labrador Current variability is important because of its intimate linkage to the meridional overturning circulation and the marine ecosystem off northeast North America. Nevertheless, knowledge of its decadal variability is inadequate because of scarcity of current meter data. By using a novel synthesis of satellite altimetry with conductivity-temperature-depth (CTD) data we investigate the Labrador Current variability over 1993-2004. Our analysis shows a decline of the volume transport by 6.3 ± 1.5 Sv in the 1990s (significant at the 99% confidence level) and a likely partial rebound of 3.2 ± 1.7 Sv in the early 2000s (significant at the 89% confidence level only). The inferred multiyear changes in the Labrador Current transport seem to be primarily barotropic and positively correlated (at the 99% level) with the North Atlantic Oscillation at zero lag implying a fast response of the regional circulation to the atmospheric forcing variability. The results compare favorably with direct current measurements and recent model-based findings on the multi-year variability of the subpolar gyre and its underlying mechanisms. The study demonstrates the feasibility of combining altimetry and CTD data for assessing the climatic variability of the boundary currents.

1P301.4 ID:5152 16:00

Power of Realtime, Continuous, Remote Observations in Capturing Patchy Episodic Fluid-Substrate Events in the Marine Realm: Examples from the NEPTUNE Canada Ocean Network.

Mairi Best , *Christopher Barnes* , *Fern Johnson* , *Lucie Pautet* , *Benoit Pirenne* , *And The Founding Scientists Of Neptune Canada*
NEPTUNE Canada
Contact: mmrbest@uvic.ca

NEPTUNE Canada is operating an 800km, 5-node, regional cabled ocean network across the northern Juan de Fuca Plate, northeastern Pacific as part of the Ocean Networks Canada Observatory. Public data flow started in 2009 and interactive instruments continue to be added to this technically challenging system which provides the continuous power and bandwidth to collect integrated real-time data on physical, chemical, geological, and biological gradients at resolutions relevant to the dynamics of the earth-ocean system.

Initial experiments were planned through workshops and international competitions, and involve a number of international research teams. In particular, fluid-substrate interactions are quantified at a number of scales across this bathymetric profile, from sediment reworking, to porewater pressure, temperature and geochemistry, to formation pressure changes at the plate scale. At coastal Folger Passage, Barkley Sound, a rocky pinnacle at 20m provides a high energy turbulent environment for a rich hardground community, and a nepheloid-dominated soft-substrate environment at 100m sees strong bottom oxygen excursions with phytoplankton remineralization. Experiments around Barkley Canyon allow quantification of changes in benthic activity with nutrient and sediment transport. There and north along the mid-continental slope, instruments on gas hydrates allow monitoring of changes in their distribution, structure, biotas and venting. Circulation obviation retrofit kits (CORKs) at abyssal ODP 1026-7 monitor changes in crustal temperature and pressure, particularly related to events such as earthquakes, tsunamis, hydrothermal convection or regional plate strain. At Endeavour, Juan de Fuca Ridge, complex interactions among volcanic, tectonic, hydrothermal and biological processes are starting to be quantified at the western plate edge. Throughout, a high resolution seismic data elucidates tectonic processes such as earthquakes, and a tsunami system allows determination of both open ocean and coastal tsunami characteristics. The infrastructure has capacity for experiments and instrumentation to expand from this initial suite. Visit neptunecanada.ca for information and opportunities.

4E0.1 ID:5153 INVITED/INVITÉ 19:30

Exploring ocean frontiers - we have more to learn

Verena Tunnicliffe
Dept. Biology & School Earth/Ocean Sciences, University of Victoria, Victoria, BC
Contact: verenat@uvic.ca

The human species is limited by terrestrial adaptations and dependence on a few senses to understand our interactions with the environment. Penetration of the oceans by humans is difficult. Lack of visual connectivity beneath the sea surface usually means “out of sight, out of mind.” Together, we will explore some of the deep places in our ocean to reveal some unknown wonders. Imagery from expeditions to hot vents, subsea volcanoes, and deep into Canadian oceans illustrates the beauty and the extraordinary dynamics of ecosystems that we never see. Canada is a leader in development of subsea technologies that allow us to undertake such exploration: submersible, remotely operated vehicles and subsea observatories are world leading. We will also look to the role of new young scientists in dealing with the growing threats to the ocean. Communication and education is possibly the best approach to ensuring better stewardship of the oceans.

2A0.2 ID:5155 INVITED/INVITÉ 09:15

Adapting to 21st century shoreline change on the Pacific coast

Philip Mote

Oregon Climate Change Research Institute
Contact: pmote@coas.oregonstate.edu

Concerns about global sea level rise during the 21st century have led to a wide range of concerted efforts to proactively manage shorelines for change. Drawing from national and international science expertise, staff in public agencies from BC and the Pacific states down to local governments are assimilating and applying the best available science. Interdisciplinary research involving glaciologists, climatologists, geologists, geomorphologists, social scientists, biologists, and others, supports and informs a range of decisions in a variety of contexts. This talk will summarize the scientific aspects of shoreline change, some policy and capital decisions informed by this science, and how knowledge- to-action networks are built around the subject.

2D0.2 ID:5156 16:15

Modeling wave-ice interactions

Dany Dumont [1], *Timothy Williams* [2], *Alison Kohout* [3], *Luke Bennetts* [4], *Laurent Bertino* [2]
[1] Institut des sciences de la mer, Université du Québec à Rimouski
[2] Nansen Environmental and Remote Sensing Center Bergen, Norway
[3] National Institute of Water and Atmospheric Research, Christchurch, New Zealand
[4] University of Otago, Dunedin, New Zealand
Contact: dany_dumont@uqar.ca

Ocean waves are the main factor affecting ice properties in marginal ice zones yet their effects on sea ice are not included in numerical models. Waves contribute to break-up the ice cover in small floes, affecting how momentum is transferred from the atmosphere and the ocean. A fragmented ice cover can no longer be described as a plastic material and the rheology must be accordingly adapted. The theory of wave scattering and propagation in ice-infested seas has progressed significantly in the past decade such that model solutions can now be applied in more realistic environments provided by today's high resolution ice-ocean models. Here we present strategies to combine these solutions, in the form of attenuation coefficients, with parameterizations of floe breaking and floe size distribution, in order to predict the size and properties of the marginal ice zone. Being able to simulate and forecast the floe size and the wave field in sea ice is of tremendous importance for offshore operations and coastal management in arctic and sub-arctic environments. The work presented is realised within the Waves-in-Ice Forecasting for Arctic Operators (WIFAR, 2010-2013) project funded by the Research Council of Norway and Total E&P Norge AS.

1C4.2 ID:5157 INVITED/INVITÉ 14:15

Observations and modelling of hydrodynamics and water quality in Lake Winnipeg

Ram Rao Yerubandi [1], *Jun Zhao* [2], *Weitao Zhang* [3], *Padala Chittibabu* [3]
[1] Environment Canada/NWRI
[2] EC/MWRI
[3] NWRI
Contact: ram.yerubandi@ec.gc.ca

Lake Winnipeg has undergone severe eutrophication in the past few decades. Algal blooms became a major issue in the lake. The current state of advanced eutrophication in this lake has been identified by the Federal Government as a priority issue requiring effective and long-term nutrient management. The goal of this project is to provide new knowledge of relative roles of physical and chemical factors

on the ecology of Lake Winnipeg at various space and time scales. In this paper, we present some results from three year field measurements of physical limnology and water quality. We use these observations to validate a three dimensional hydrodynamic model of lake circulation, thermal structure and mixing in the lake. Examples of eutrophication model results will also be discussed.

4B1.5 ID:5158 11:45

What Is A Good Forecast: User-oriented verification

Laurence Wilson
(Presented by *Lawrence Wilson*)
Meteorological Research Division
Contact: lawrence.wilson@ec.gc.ca

Allan Murphy has said that forecast verification is a useful activity only if the results lead to some decision about the forecast product being verified. This implies there must be a user for the verification output. And, it also implies that the verification methodology must be designed to tell the user what he or she wants to know about the quality of the forecast. User-relevant verification is a necessary but often ignored or under-emphasized component of current prediction systems. Verification summaries which use traditional measures, for example those routinely prepared by operational centers, may be useful for some, but are typically widely disseminated as if they should satisfy all users of forecasts. Generally, the more care that is taken to design a verification system to meet the specific needs of a particular user group, the more likely it is that the verification system will produce output that is useful in decision-making.

The meaning of “user-relevant” verification will be discussed, in the context of verification of forecasts for specific user groups such as VANOC, and for the operational forecaster community. Several examples will be presented of recent verification research with clearly defined user focus.

1B2.6 ID:5159 12:15

Meteorological Training Of New Atmospheric Monitoring Network Technicians

Keith Clifford
Meteorological Service of Canada
Contact: keith.clifford@ec.gc.ca

The traditional route by which meteorological inspectors who audited and maintained several types of weather stations came from a pool of technically adept meteorological technicians. While the majority of these individuals had very strong meteorological backgrounds they weren’t required to maintain very complicated technologies. As the field of data acquisition progressed, more and more sophisticated systems came into play. Additionally the requirement for maintainers who have strong skill sets in electronics has become prevelant. Current recruiting of new technical services personnel within the Meteorological Service of Canada places an emphasis on electronic expertise but still requires the ab initio technicians to undergo significant meteorological training to give them the troubleshooting abilities to diagnose faults with stations, sensors and networks. The most efficient way to do this is to train these individuals to be aviation weather observers.

In the past such training was conducted at several central schools where the individuals became “met techs” and followed a well defined career path. Current operational weather observers are mostly working for contractors who are charged with continuing these services on behalf of Nav Canada. In order to ensure that new Environment Canada technical services personnel have the requisite meteorological background to effectively perform their duties a decision was made in last decade to modify the previous Contract Weather Observer Course training and tailor it to the needs of our new techs. The instruction places a heavy emphasis on theory to start with and builds upon practical experience dealing with all of the major parameters of data acquisition. A major focus is the daily use of forecast and real data in building practical skills in remote troubleshooting and asset management. This presentation outlines the current state of this unique facet of meteorological technical training. As part of the technical apprenticeship program, the new techs are required to undergo a period of operational weather observing. A description of the Surface Weather Observing Course conducted by MSC-Ontario Region at Hamilton, Ontario will be the main focus the presentation.

3C2.2 ID:5160 14:00

Hydrologic impacts of climate change in select watersheds of British Columbia, Canada

Markus Schnorbus [1], *Katrina Bennett* [2], *Arelia Werner* [1], *Anne Berland* [1]
[1] Pacific Climate Impacts Consortium
[2] University of Alaska Fairbanks
Contact: mschnorb@uvic.ca

Within British Columbia (BC), Canada, hydroelectricity is the largest source of electric power generation. Much of this hydroelectric power, which is predominantly generated from large heritage assets in the Peace, Columbia and Campbell River systems, may be susceptible to the hydrologic impacts of climate change. A high-resolution, physically-based macro-scale hydrologic model has been applied to quantify the hydrologic impacts of projected climate change within the these three study watersheds, which between them represent a range of hydro-climatic regimes and scales. This study utilized a suite of eight global climate models (GCMs) driven by three emissions scenarios, intended to capture a range of high, medium and low projected greenhouse gas emissions, to project a wide range of potential climate responses for the 2050s time period (2041 to 2070). Climate projections were statistically downscaled and used to drive the hydrology model at high spatial resolution. This methodology of selecting multiple GCMs coupled to three emissions scenarios covers a large range in potential future climates for BC and explicitly addresses both emissions and GCM uncertainty in the final hydrologic projections. Streamflow projections were made for several project sites within the study watersheds, corresponding to current hydro-generation sites, potential sites of future hydroelectric development, as well as several natural drainages. Results of projected changes in annual and monthly streamflow will be presented for a small sub-set of project sites.

2D4.1 ID:5161 INVITED/INVITÉ 16:00

The Role of Submarine Canyons and Banks in Nutrient Supply to the Canadian/US Western Coastal Ocean

Barbara Hickey
University of Washington
Contact: bhickey@u.washington.edu

In a typical Eastern Boundary Current System, upwelling of nutrient-rich deep water driven by alongshore wind stress is the primary source of nutrients that fuel summertime coastal productivity. A paradox exists in the upwelling system offshore of the southern Canadian and US west coast: productivity (as determined by chlorophyll-a concentration) is highest where upwelling- favorable wind stress is weakest; namely, off southern British Columbia /northern Washington (Thomson and

Ware, 2005). Although greater phytoplankton density might be explained in part by increased retention due to the wider shelves in those regions, or by weaker offshelf transport in the surface Ekman layer, or by the presence of the Columbia River plume, those mechanisms cannot readily explain the fact that nutrient concentrations in upwelled waters are equal to or greater than those farther south in the regions with much stronger upwelling winds, such as Oregon and California. One explanation—direct nutrient contribution by the Columbia River—has recently been shown to be minimal. Another buoyancy-driven coastal feature, the effluent from the Strait of Juan de Fuca, does provide the majority of the nutrients on the Southern British Columbia shelf—however these nutrients are themselves derived from coastal upwelling processes rather than the inland watersheds. Another explanation for the productivity paradox—enhanced or deeper upwelling and/or alteration of circulation by banks and the numerous submarine canyons—is a more likely possibility. Model results demonstrate that upwelling along the southern rim of the submarine canyons greatly enhances upwelling across the shelf break. The complex interaction of the topographically-controlled upwelling from and through Juan de Fuca submarine canyon and La Peruse Bank with the buoyancy controlled Strait of Juan de Fuca effluent will be discussed as well as the effects of forcing by remote winds and the importance of the poleward slope undercurrent in controlling upwelling in this region.

3C3.4 ID:5162 14:15

The distribution of 231Pa and 230Th in the Pacific Ocean：A study from a 2D model

Yiming Luo [1], *Roger Francois* [2], *Susan Allen* [3]
[1] University of British Columbia
[2] rfrancoi@eos.ubc.ca
[3] sallen@eos.ubc.ca
Contact: yluo@eos.ubc.ca

Sedimentary 231Pa/230Th has been used as a kinematic tracer (McManus et al., 2004) to investigate past changes in the rate of the Atlantic Meridional Overturning Circulation (AMOC). We recently developed a two-dimensional scavenging model, which confirmed that the spatial distribution of sediment 231Pa/230Th in the Atlantic is largely controlled by, and records the strength of the AMOC (Luo et al., 2010). Here, we present a similar 2D scavenging model for the Pacific Ocean. Our model reproduces the vertical profiles of dissolved 230Th and 231Pa, measured in the North Pacific, and predicts a spatial pattern in sediment 231Pa/230Th consistent with the limited sedimentary data base available thus far in this ocean. This finding suggests that, as for the Atlantic Ocean, sedimentary 231Pa/230Th could also document the changes in deep water circulation that occurred in the Pacific Ocean during the last glacial climatic cycle and could provide important insight to assess the impact of these changes on atmospheric CO2 and deep sea carbon sequestration (Jaccard et al., 2009).

3B6.1 ID:5163 10:30

A classification of stratified shear flow instabilities and implications for mixing in geophysical flows

Jeff Carpenter [1], *Edmund Tedford* [2], *Neil Balmforth* [2], *Greg Lawrence* [2]
[1] Eawag, Swiss Federal Institute of Aquatic Science
[2] University of British Columbia
Contact: jeffcarp@gmail.com

Although the Kelvin-Helmholtz (KH) mode of instability is the most cited in terms of the stratified shear layer, it has recently been found that the Holmboe (H) mode may produce a comparable (or even

greater) amount of mixing (Smyth & Winters, 2003). This study, and a series of follow up studies, have raised the possibility that both the amount, and the character, of mixing that occurs as a result of stratified shear layer instabilities is dependent on the type of instability that grows. This raises the fundamental question of how we are to distinguish between instability types. Traditionally, a distinction between KH and H types has been made in terms of phase speed; the KH is stationary with respect to the mean flow, whereas the H modes propagate. However, this distinction breaks down when any asymmetry is present between the velocity and density profiles.

Following previous work, we propose a classification system for stratified shear layer instabilities that is based on wave interactions. These waves may occur on vorticity gradient regions, and on density gradient regions, and their interaction can be interpreted as a mechanism for instability growth. This interpretation of shear instability leads naturally to a classification system that is composed of three fundamental modes: the KH, H, and Taylor- Caulfied (TC) modes. Though previous work on these instabilities has been restricted to piecewise profiles, we describe an extension to smooth profiles, and demonstrate by example how to classify instabilities in a geophysically relevant stratified shear flow in the Fraser River estuary.

2C3.3 ID:5165 14:30

A quasi-geostationary view of the Arctic and environs: PCW/PHEMOS for Arctic weather, climate and air quality

Norm O'Neill [1], *John Mcconnell* [2], *Tom Mcelroy* [3], *Brian Solheim* [2], *Henry Buijs* [4], *Peyman Rahnama* [5], *Kaley Walker* [6], *Randall Martin* [7], *Chris Sioris* [3]
[1] CARTEL, Universite de Sherbrooke
[2] York University
[3] Environment Canada
[4] ABB-Bomen
[5] COMDEV
[6] University of Toronto
[7] Dalhousie University
Contact: norm.oneill@USherbrooke.ca

The Arctic is a region of rapid climate change with warming temperatures and depleting multi-year ice which may be exacerbated by transport of black carbon from boreal forest fires and anthropogenic material from mid- and high-latitudes. It is also the source of winter storms delivering cold air to lower latitudes. Currently, Arctic data is available from polar orbiting satellites, but only intermittently at a given location. 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 continuous Arctic coverage. The baseline PCW instrument for delivering meteorological data to the forecasting community is a 12-channel MODIS-like imager. The CSA is exploring the possibility of complementary instruments for atmospheric science. By the spring of 2011, a Phase-0 study for the development of an atmospheric package, called PHEMOS, led by ABB-Bomen, COM DEV and scientists from university and government will be completed. We present the case for a suite of innovative imaging instruments to provide Arctic weather, climate and air quality data from the PCW satellite. The science goals of the PHEMOS instruments (imaging FTS, UV-Vis-NIR spectrometer and possibly a SHS spectrometer) in concert with those of the PCW imager are the provision of basic weather information, the collection of synoptic-scale air quality (gas and aerosol) measurements to better understand the Arctic-wide impact of industrial and agricultural pollution, boreal forest fire smoke and volcanic aerosols as well as the acquisition of columnar data on CH_4 and CO_2 over the Arctic to assess perturbations due to their increasing release from the permafrost and from shallowly buried clathrates. We will outline the scientific objectives and the status of the current instrument design.

1C2.2 ID:5166 14:15

Development of a next generation moored buoy system

Chris Marshall
Manager of Marine Networks - Environment Canada - Meteorological Service of Canada
Contact: chris.marshall@ec.gc.ca

Environment Canada operates a network of 47 moored weather buoys across Canada, with buoys installed in the Pacific and Atlantic Oceans, as well the Great Lakes and other Interior Lakes. A number of the buoys have now been in service for over 30 years, with the last major change made to their on-board data collection and communication management systems in the late 1990's. All buoys in the network currently utilize the WatchMan 100 system developed by AXYS Technologies Inc. EC's Marine Networks is presently developing a suite of requirements for the deployment of next generation buoy "payloads" (onboard data, communications, and data management) that will include a greater degree of flexibility, as well as more robust autonomous operation.

Some of these features will include use of improved satellite technologies to allow for bi-directional communications, as well as easier integration of a broader range of environmental sensors (oceanographic, biological etc.). We also envision different modes of operation, with increased rates of sampling and reporting during episodes of signification weather. This could for example include provision of 10 minute updates of wind and pressure observations during Tropical storms in Eastern Canada. Improved communications will also allow for easier remote diagnosis of system problems, with the ability for example to reset hardware, and push updated firmware and software remotely. It is hoped that this functionality will reduce the number of prolonged data outages, as well as amount of ship-time required to maintain the network, while continuing to meet the needs of a broad range of clients in the public and private sectors.

2C1.2 ID:5167 14:30

Possible Alternative Configurations of the High Resolution Deterministic Prediction System

Anna Glazer , *Jason Milbrandt*
RPN, Environment Canada
Contact: anna.glazer@ec.gc.ca

The High Resolution Deterministic Prediction System (HRDPS), currently run by the Canadian Meteorological Centre in experimental mode, is moving towards a switch to operational status. Recent modifications to the system were based on the experimental high-resolution NWP system designed for the Vancouver-Whistler region and run in support of forecasting for the 2010 Winter Olympic and Paralympic Games. These modifications were applied to all four domains in the current HRDPS. Further modifications to the system are currently being explored.

Given the large computational demand for such a modeling system and the computational constraints when running a system operationally, optimization of the system is an important consideration. This study will examine a feasibility of relaxing the homogeneous treatment of all the high resolution domains over Canada. Specifically, the possibility of different configurations -- horizontal grid spacing and model time step -- will be analyzed and their impact on the quality of forecasts will be presented.

1P306.3 ID:5168 16:00

Spatial wind patterns and their impacts on drift in Newfoundland bays

James Helbig , *Pierre Pepin* , *Guoqi Han*
(Presented by *Guoqi Han*)
Fisheries and Oceans Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

Spatial (and temporal) variations in the wind field generate corresponding variations in the ocean currents and mixing, and subsequently affect the transport and spatial distribution of buoyant passive drifters like plankton, including fish eggs and larvae. This is especially important in coastal regions where orography induces local wind variability and bathymetry modulates currents. For management applications like surveying the number of eggs in a bay as input to the estimation of fish stock abundance, spatial and temporal variability in egg concentration can be extremely important. Therefore, oceanographic models that predict fish egg drift should be forced by realistic wind fields, i.e. those that contain small scale structure, which however are rarely available from in situ observations or numerical weather models. Here we use RADARSAT-1 SAR imagery to retrieve spatial wind patterns in two Newfoundland bays (Trinity and Conception). Comparisons were made with QuikSCAT winds which, together with weather maps, provided a larger scale perspective. The SAR winds revealed distinct patterns within each bay. An error analysis was carried out to determine the uncertainty in wind speed due to uncertainty in wind direction. The surface circulation and egg drift patterns were then simulated under spatially uniform and spatially variable winds respectively. The model results were discussed to elucidate the importance of accounting for the spatial wind structure to egg survey accuracy.

1P205.2 ID:5169 16:00

A climatology for surface ozone and PM2.5 for North America using objective analysis techniques.

Alain Robichaud , *Richard Menard*
Environment Canada
Contact:

Developing a sound climatology for surface pollutants is difficult due to either important model biases and/or lack of complete observation coverage. However, combining and optimizing information of both AQ models and surface data in an appropriate way as described below should produce an accurate climatology at relatively low cost. In this paper, we have constructed such a climatology by combining the information provide by of a long series of AQ model outputs (CHRONOS model is used from 2002-2009) and observations during the same period (US/EPA AIRNOW database). The climatology is valid for North America (more specifically for US and southern Canada) and is based on an improved objective analysis algorithm which performs a direct matrix inversion. An empirical technique using a sensitivity test which modifies “on-the-fly” the correlation length and background error statistics while monitoring the impact on the chi squared statistics has been developed. In addition, a careful bias correction to eliminate systematic CHRONOS model errors in the output analyses has also been applied to the analysis increment field. Validation with both dependent and independent data suggests the apparent success of the methodology. Applications are discussed such as the calculation of air pollution trend over a decade, mapping of cumulative indices such as SUM06, AOT40, etc. It is believed that this work provides the first mapping in North America of a climatology for surface ozone and PM2.5 using independent sources of information (i.e. optimizing model and observations).

3B6.4 ID:5170 11:15

The effect of Reynolds number on mixing in Kelvin-Helmholtz instability

Mona Rahmani [1], *Greg Lawrence* [1], *Brian Seymour* [2]
[1] Department of Civil Engineering, UBC
[2] Department of Mathematics, UBC
Contact: mrahmani@civil.ubc.ca

Mixing induced through the life-cycle of Kelvin-Helmholtz instabilities in sheared, density stratified flows is studied for a range of Reynolds numbers using direct numerical simulations. As the Reynolds number increases there is a transition in the characteristics of the mixing. This mixing transition region is compared to that observed in the laboratory experiments of Breidenthal 1981 and Koochesfahani & Dimotakis 1986. Through examining the flow properties at different stages and the exchange between the energy partitions we explain the mixing behaviour. The maximum total amount of mixing occurs when the turbulent flow most efficiently and persistently extracts energy from the mean flow to induce mixing.

1P201.1 ID:5171 16:00

Comparison of cloud properties and precipitation between observations, reanalyses, and models.

Christophe Corbel , *Philip Austin*
University of British Columbia
Contact: ccorbel@eos.ubc.ca

Future climate can only be forecast using models, usually atmospheric or coupled General Circulation Models (GCMs). Quantitative evaluation of their performances is critical for scientific and societal purposes. Clouds are key drivers of the differences between climate model simulations, and of model errors compared to observations. Here we investigate the agreement of precipitation and cloud properties between data (ISCPP and MODIS satellite cloud observations), reanalysis (ERA40 and ERA Interim), and models (Canadian Centre for Climate Modeling and Analysis (CCCma) AGCM3 and CanAM4).

Lower Tropospheric Stability (LTS) and Estimated Inversion Strength (EIS (Wood and Bretherton, J. Atmos. Sci., 2006) taken from ECMWF reanalysis are used as measures of atmospheric stability, along with the vertical velocity at 500 hPa (w500), to define cloud classes. We focus on two regimes (trade cumulus and stratocumulus) defined by different w500, and LTS or EIS thresholds (Medeiros and Stevens, 2009). Taylor diagrams, LTS-w500 and EIS-w500 histograms are used to conditionally sample precipitation and cloud properties. We compare the statistics for these thermodynamically determined regimes with the ISCCP base optical depth/cloud top pressure histograms of Williams and Webb (2009). We find broad agreement with the geographical location and cloud fraction between the two approaches, but Taylor diagrams show differences in the variability in the cloud fields, depending on whether the regime selection is done with EIS and LTS.

3E1.1 ID:5172 INVITED/INVITÉ 16:30

Towards an operational high resolution deterministic prediction system

Jason Milbrandt [1], *Natacha Bernier* [1], *Amin Erfani* [2], *Andre Giguere* [2], *Anna Glazer* [1], *Manon Faucher* [2], *Francois Lemay* [2], *Jocelyn Mailhot* [1], *Ruping Mo* [3]
[1] Environment Canada (RPN)
[2] Environment Canada (CMC)
[3] Environment Canada (National Laboratory for Coastal and Mountain Meteorology)
Contact: jason.milbrandt@ec.gc.ca

For the past several years, the Canadian Meteorological Centre (CMC) has been running the Global Environmental Multiscale (GEM) model over several high-resolution (2.5 km grid spacing) limited-area model (LAM) domains in Canada in real-time, experimental mode. In support of forecasting for the 2010 Vancouver Winter Olympics, a special configuration of the GEM-LAM was run and was shown to be very skillful at forecasting high-resolution meteorological phenomena in regions of complex terrain. This test configuration will form the basis for next major upgrade to the GEM-LAM-2.5 system. Further, the system will move from experimental to operational status in the near future. This modelling system -- now referred to as the High Resolution Deterministic Prediction System (HRDPS) -- is used more and more by operational CMC forecasters and the GEM-LAM is used increasingly by researchers throughout the country, both within Environment Canada and universities.

This talk will provide an overview of the current HRDPS along with a discussion of the current research and development that is currently underway towards improving the system and making it an official operational system.

3P208.2 ID:5173 15:30

The two-moment bulk microphysics scheme in the GEM-LAM

Jason Milbrandt [1], *Anna Glazer* [1], *Julie Theriault* [2]
[1] Environment Canada (RPN)
[2] National Center for Atmospheric Research
Contact: jason.milbrandt@ec.gc.ca

A detailed, multi-moment bulk microphysics parameterization scheme – used to compute the effects of cloud microphysical processes and the formation of precipitation in high resolution atmospheric models – was developed a few years ago at McGill University and later implemented into Environment Canada's library of physics subroutines used in the GEM model. Several changes to this parameterization, generally known as the Milbrandt-Yau scheme, have been made since it was first published in 2005. In 2007, the single-moment version was implemented into the experimental GEM-LAM 2.5-km system. In the special high-resolution GEM-LAM system, run in support of forecasting during the 2010 Vancouver Winter Olympics, the full two-moment version was used. This version included several new experimental forecast fields, including a prognostic solid-to-liquid ratio for improving the forecast of snowfall quantities. Research on the improved treatment of graupel and hail and on the treatment of partially melted snow is ongoing.

The High Resolution Deterministic Prediction System (GEM-LAM 2.5-km) was recently upgraded, based on the configuration used for the 2010 Vancouver games, and is planned to have formal "operational" status in the near future. In this system, the latest two-moment version of the Milbrandt-Yau scheme is used. The scheme has thus moved from a purely research tool to an operational parameterization scheme. An overview of the scheme, and a description of the available forecast fields, will be presented along with a summary of the recent research and development.

2C6.4 ID:5175 14:45

Quantifying Intraseasonal Wintertime Climate Variability during Different Phases of ENSO and PDO over Canada

Amir Shabbar , *Bin Yu*
Environment Canada
Contact: amir.shabbar@ec.gc.ca

In this study we examine the intraseasonal behaviour of wintertime temperatures and precipitation over Canada during the in-phase and out-of-phase occurrences of the interannual ENSO and the interdecadal PDO events. Results on the ratio of the intraseasonal variance to the total variance, the power spectrum, and the frequency anomaly of extreme events during the different combinations of ENSO and PDO will be presented.

4B2.5 ID:5176 11:30

Weighting factors of regional climate models combined with an evolution algorithm for the Southern Quebec region

Hyung-Il Eum [1], *Philippe Gachon* [2], *René Laprise1* [1]
[1] University of Quebec at Montreal
[2] Environment Canada/University of Quebec at Montreal
Contact: hieum@sca.uqam.ca

In recent years, various simulations of regional climate models (RCMs) have been made available and consequently ensemble size of regional climate scenarios from different boundary conditions of available Atmosphere-Ocean Global Climate Models (AOGCMs) runs. However, the large spread of climate responses between climate models is widely acknowledged even under an identical greenhouse gas emission scenario by large uncertainty induced from natural variability, physical parameterization of climate models, and the combined errors from the AOGCM-RCM cascade. Therefore, the assessment of multiple climate models has been implemented and uncertainties of climate projections have been estimated by a number of state-of-the-art techniques. Since the combined weighting scheme not only has flexible structure that accepts to change performance metrics and relative importance of each metric corresponding to user's interests, but also is less expensive in computational complexity, it has been frequently used to assess climate scenarios and to address their inherent uncertainties. In meteorological and hydrological operations, however, the relative importance of performance metrics should be considered to reflect seasonality of a local region and end user's applications. This study employed an optimization scheme, differential evolution (DE) algorithm, to decide an optimal relative importance of performance metrics that may lead to improving the performance of the weighting factor procedure. This study investigates the relative importance of each performance metric for precipitation and temperature according to the seasons, and how much the performance is improved by weight averaged references with optimal and equal relative importance of performance criteria.

2A0.1 ID:5177 INVITED/INVITÉ 08:30

The science of "ocean dead zones" and the changing Pacific

Peter Brewer
Monterey Bay Aquarium Research Institute
Contact: brpe@mbari.org

Climate change and ocean acidification are two of the powerful forces now actively driving change in the modern Pacific Ocean. Too often these phenomena have been treated as separate effects rather than being intimately linked; yet the simultaneous build up of both heat and CO2 in the upper ocean are clearly recognizable from observations today. The tools we now have are not adequate for useful prediction of outcomes for marine life from these combined effects, but a sense of direction is clearly emerging.

For calcifying organisms such as coral reef systems, shellfish etc it is the carbonate ion concentration that is critical and I show active perturbation field experiments (FOCE) that are now extending the laboratory observations of these impacts.

For higher organisms the prospect of a large increase in the hypoxic areas of the ocean has been raised. Here I show that it is possible to create systems that treat the impacts of rising temperature, declining oxygen, and rising CO2/falling pH in a more rigorous manner. For historical reasons ocean scientists have typically reported dissolved O2 levels in mass units for water mass identification and mixing processes, but CO2 levels as partial pressures to emphasize the critical gas exchange processes. For impacts on marine life the ratio of partial pressures is the appropriate factor expressed simply but non-linearly from the Gibbs relationship as log10(pO2/pCO2), with varying thresholds for individual species. It is clear that declines in O2 levels from physical climate change, combined with added fossil fuel CO2 can have significant impact, with the west coasts of North and South America being particularly vulnerable. Models today give mixed results in attempting these projections, in large part because critical temperature dependencies are not well understood and formulated. Video footage of life across this threshold gives a clear example of limits.

1C5.3 ID:5178 14:45

Modelled Precipitation Changes Under a Simple Geoengineering Scheme

Michael Shumlich [1], *Nathan Gillett* [2], *Charles Curry* [2], *Andrew Weaver* [1]
[1] School of Earth and Ocean Sciences, University of Victoria
[2] Canadian Centre for Climate Modelling and Analysis
Contact: mjs@uvic.ca

One proposed scheme for dealing with anthropogenic climate change is the altering of the Earth's albedo through the use of sulfate aerosols in the stratosphere as a planetary scale geoengineering project. Such a geoengineering scheme could potentially offset the warming from increased atmospheric greenhouse gas concentrations. However, the injection of sulfate aerosols into the stratosphere could also have consequences for the Earth's hydrologic cycle. These questions have been explored using output from the CCCma's CanESM2 model, in two experiments carried out as a part of Geoengineering Model Intercomparison Project. The first experiment involved a quadrupling of the atmospheric carbon dioxide concentration with a concurrent, compensatory, reduction of the solar constant, representing the albedo increasing effect of sulfate aerosols. The second involved a 1% per year increase in atmospheric carbon dioxide concentration and a corresponding reduction in solar forcing to counteract the forcing from the increasing greenhouse gas concentration. After evaluating the model's simulated precipitation over the historical period, the precipitation response in these two experiments will be examined.

3C0.2 ID:5179 14:00

Geographical dependence of blocking high contributions to the stratospheric variability through enhancement and suppression of upward planetary-wave propagation

Yvan Orsolini [1], *Kazuaki Nishii* [2], *Hisashi Nakamura* [2]
[1] Norwegian Institute for Air Research
[2] University of Tokyo
Contact: orsolini@nilu.no

Many previous studies have noted the importance of blocking high (BH) development on the occurrence of stratospheric sudden warming. By identifying and compositing prominent events observed around each of the data grid points over the Northern Hemisphere, we reveal distinct geographical dependence in how a BH modifies upward propagation of planetary waves into the stratosphere. Tropospheric BHs that develop over Canada, the North Atlantic and Europe tend to enhance PW propagation into the stratosphere, leading to warming of the polar stratosphere. In contrast, the propagation tends to be suppressed by BHs developing over the western North Pacific and the Far East, resulting in cooling of the polar stratosphere. Recent examples of Western Pacific pattern events leading to an extremely cold polar stratosphere will be shown. This geographical dependence is found to arise mainly from the dependence of interference between the climatological-mean planetary waves and upward-propagating Rossby wave packets emanated from BHs.

4B6.5 ID:5180 11:45

Impact of the 2007 Arctic sea ice reduction in coupled ocean-atmosphere autumn hindcasts

Yvan Orsolini [1], *Retish Senan* [2], *Rasmus Benestad* [2], *Arne Melsom* [2]
[1] Norwegian Institute for Air Research
[2] Norwegian Meteorological Institute
Contact: orsolini@nilu.no

The Arctic sea ice extent has rapidly been decreasing in all seasons since monitored from space in the late seventies, and the highest negative trend is observed in late summer. Superposed on this negative trend, there is considerable inter-annual variability and marked reductions were observed in recent years. We characterise the autumn and early winter atmospheric response to low summer Arctic sea ice extent, and examine whether this influence extends beyond the boundaries of the Arctic Ocean. To this end, we performed hindcasts with prescribed sea-ice with the state-of-the-art coupled ocean-atmosphere seasonal forecast model from ECMWF. We focus on summer 2007, when Arctic sea-ice extent reached a record low. The 5-member ensemble hindcasts have a high atmospheric resolution (T159), and are initialized with atmospheric and ocean analyses valid for 1 October 2007. Robust, warm autumn anomalies over the Pacific and Siberian sectors of the Arctic, as high as 10C at the surface, are found in the hindcasts using the 2007 sea ice. In December, a regime change is occurring, and hindcast anomalies consist of weaker temperatures extending through the troposphere, deeper Aleutian and Icelandic Lows, and intensified upper-level jets over both oceanic sectors, but especially over the Pacific Ocean. A potential predictability analysis indicates that the sensitivity of surface temperatures along the Pacific coast of Asia is the strongest impact outside of the Arctic Ocean, in December. A slowly evolving component of the Earth’s climate system, sea-ice is indeed important for seasonal forecasting at high latitudes. When realistic 2007 sea ice extent is prescribed, a higher correlation of surface temperatures with meteorological analyses is found at high latitudes, lasting for about a month.

4B4.5 ID:5181 11:45

Processes impacting model drift in the sub-polar gyre in eddy permitting simulations

Paul Myers

Department of Earth and Atmospheric Sciences, University of Alberta
Contact: pmyers@ualberta.ca

Eddy-permitting model simulations of the North Atlantic Ocean open suffer serious drift in terms of salinity and wintertime mixed layer depth. Thus, the resulting model hydrography and interior circulations are often poorly represented. This presentation focuses on understanding issues related to the causes of this drift and works towards suggesting solutions for reducing these drifts in future simulations. The relative role of initial conditions, air-sea flux representation and the representation of sea ice in the boundary currents surrounding Greenland will be discussed.

1P502.2 ID:5182 16:00

The Role of Resolution in Modelling Fluxes Through the Canadian Arctic Archipelago

Qiang Wang , *Xianmin Hu* , *Paul Myers*
(Presented by *Paul Myers*)
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. Here we will compare the role of model resolution in determining the pathways through the Canadian Arctic Archipelago. The focus will be on the volume and freshwater transport as well as the sea ice transport. Simulations used range from a coarser resolution global configuration to a 6.5-9.5 km resolution Canadian Arctic Archipelago configuration.

1P504.2 ID:5183 16:00

Development of a Modelling Capacity for the Canadian Arctic Archipelago

Xianmin Hu , *Qiang Wang* , *Paul Myers*
(Presented by *Paul Myers*)
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 validation will be presented. The focus will be on the models ability to estimate fluxes through the Canadian Arctic Archipelago as well as present limitations.

1C5.4 ID:5184 15:00

The ratio of land to ocean temperature change under global warming

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

Climate simulations and the observation-based record both indicate that the land warms more than the ocean under global warming. The ratio of land to ocean temperature change is quite stable even for

large simulated temperature changes. As well, despite the land warming considerably more than the ocean, energy transport changes are not such as to remove heat from the land and supply it to the ocean region but rather the reverse.

This behaviour is analyzed from a forcing/feedback view of the energy balance using the results of climate change simulations from coupled models contributing to the CMIP3 data archive. It is found that local feedbacks over the ocean, especially the equatorial Pacific, are not able to counteract the positive radiative forcing imposed. The resulting excess of energy is transported to the land, despite the fact that it has warmed more than the ocean. From an energetic point of view, the land must warm sufficiently to radiate away both the energy from the forcing over land but also the energy imported from the ocean region.

4B6.1 ID:5185 INVITED/INVITÉ 10:30

Dreams of decadal prediction

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

There is a long history of extended range predictions which depend on a variety of statistical or other relationships. Some methods presume connections between solar, lunar or other planetary influences (e.g. Farmer's Almanac), some are proprietary and some are based on psychic powers as can be seen on the Internet. The dream of skillful decadal climate prediction remains elusive but alluring.

The goal here is to survey some of the recent developments in decadal climate prediction and predictability research leading toward the CMIP5 coordinated decadal prediction experiment and the assessment of "Near-term Climate Change: Projections and Predictability" in Chapter 11 of the IPCC.

3C0.1 ID:5186 INVITED/INVITÉ 13:30

Is the Brewer-Dobson Circulation Driven by Tropospheric Baroclinic Waves or by Upper Stratospheric Planetary Waves?

John Wallace [1], *Rei Ueyama* [1], *Dargan Frierson* [1], *Edwin Gerber* [2]
[1] University of Washington
[2] Courant Institute
Contact: wallace@atmos.uw.edu

Studies based on TEM downward control diagnostics as applied to tropical upwelling at the 100 hPa level emphasize the role of low latitude, lower stratospheric planetary and synoptic scale waves in driving the time-mean Brewer-Dobson Circulation and the seasonal and nonseasonal variations about the mean. In contrast, statistical analysis of reanalysis datasets and model simulations show that the breaking of high latitude planetary waves in the upper stratosphere exerts a strong influence on tropical lower stratospheric temperature, which is presumably a measure of upwelling. Key elements in reconciling these seemingly contradictory interpretations are (a) recognizing the different character of the Lagrangian mean meridional circulation below and above 70 hPa and (b) extending the analysis high enough into the stratosphere to be able to resolve the equatorward extension of the momentum fluxes at 20 hPa and above.

4C2.5 ID:5187 14:45

Dynamical and statistical downscaling comparisons: assessment of regional changes in climate variability and extremes

Philippe Gachon [1], *Milka Radojevic* [2], *Andrew Harding* [3], *René Laprise* [4], *Van Nguyen* [2]
[1] Environnement Canada
[2] Global and Environmental Climate Change Centre, McGill University
[3] Global and Environmental Climate Change Centre, UQAM
[4] ESCER (Étude et Simulation du Climat à l'Échelle Régionale) at the University of Quebec at Montreal
Contact: philippe.gachon@ec.gc.ca

In order to evaluate plausible changes in climate variability and extremes at the regional or local scale, the use of regionalization techniques, such as Regional Climate Models (RCMs) and Statistical Downscaling (SD) methods, is needed. Each downscaling technique has its own limitation and advantage according to model parameters and their sensitivity to various forcing factors, and/or stability of sub-grid scale processes (i.e. for RCMs) or of statistical relationships defined between predictors and predictand (i.e. for SDs). This study investigates the results of an ensemble of downscaling simulations in which multiple RCMs and various multisite SDs models are compared and evaluated over various areas in southern Canada. The first part of this study presents the ability of independent RCM simulations to reproduce observed variability and extremes in temperature and precipitation regimes is evaluated by comparing seasonal indices and those derived from the North American Regional Reanalysis (NARR), and gridded observed datasets. The focus is over recent decades (1961-2004) using RCM's simulations from various versions of the Canadian RCM (CRCM), and from the NARCCAP project (http://www.narccap.ucar.edu/). Results suggest that the RCMs' performance over the current 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. Finally, RCM and multisite SD simulations are intercompared over southern Québec to get insight about the added values and uncertainties arising from the choice of downscaling model. The implication of this downscaling intercomparison exercise for regional climate scenarios and probabilistic information development is also discussed.

1C4.1 ID:5188 INVITED/INVITÉ 14:00

Simulation of three-dimensional circulation and hydrography over the Grand Banks of Newfoundland

Guoqi Han [1], *Zhimin Ma* [2], *Brad Deyoung* [2], *Mike Foreman* [1], *Nancy Chen* [1]
[1] Fisheries and Oceans Canada
[2] Memorial University
Contact: Guoqi.Han@dfo-mpo.gc.ca

Ocean currents and associated hydrographic conditions are important to, and at times control the transport and survival of marine eggs and larvae. A good example of this is the impact of the Labrador Current and its variability on the Newfoundland Shelf ecosystem. Nevertheless, there are few ocean models that both adequately resolve the cross-shelf structure of the Labrador Current and that are sufficiently evaluated against in situ observations at tidal, synoptic and seasonal scales. We present a three-dimensional, high-resolution, prognostic, nonlinear circulation model, the finite volume coastal ocean model (FVCOM), for the Newfoundland offshore. The FVCOM uses unstructured grid in the horizontal and thus allows efficient and effective use of grid resolution to resolve coastal- and shelf-scale features. The model results are evaluated against current meter measurements, vessel-mounted

ADCP data, and tide-gauge observations. The climatological monthly-mean currents are compared with those from an earlier finite-element model using the same horizontal grid mesh. The FVCOM monthly-mean currents over the shelf and slope show good agreement with observations and substantial improvement over those from the finite-element model. The FVCOM tidal elevations agree well (4 cm of the root-sum-square absolute error for the total tidal height) with observations, and show improvement over previous tidal models over the Labrador Shelf. The hindcasts for spring-summer 1999 show reasonable skills in reproducing currents (a velocity difference ratio of 0.68 at the Flemish Cap transect), temperature (a root-mean-square (RMS) accuracy of 2 degree C) and salinities (an RMS accuracy of 0.5 psu) at selected locations and transects. The model solutions clearly indicate a seasonal decrease of the Labrador Current at depth from spring to summer, and the importance of the Ekman flow near the surface on the synoptic scale.

2B5.1 ID:5190 INVITED/INVITÉ 10:30

Recent changes in water masses of the southern California Current

Steven Bograd [1], *Carmen Castro* [2], *Francisco Chavez* [3], *Curt Collins* [4], *Vincent Combes* [5], *Manu Di Lorenzo* [5], *Mark Ohman* [6], *Ryan Rykaczewski* [7], *Frank Whitney* [8]
[1] NOAA SWFSC
[2] CSIC Spain
[3] MBARI
[4] Naval Postgraduate School
[5] Georgia Tech
[6] Scripps Institution of Oceanography
[7] Princeton University
[8] DFO-IOS
Contact: steven.bograd@noaa.gov

We use historical hydrographic data from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program to explore the temporal variability of physical and chemical properties of water masses within the Southern California Bight over the period 1949-2010. We describe seasonal to interannual variability and long-term property trends, including recent declines in dissolved oxygen, a consequent shoaling of the hypoxic boundary, increases in inorganic nutrient content, and large changes in Redfield ratios. We explore the causes of these trends, both in terms of local biological processes and changes in source waters to the region. Significant changes in the oxygen content and nutrient composition of California Undercurrent waters, which are upwelled upstream, could have important implications for the California Current ecosystem. Similarly, expansion of the oxygen minimum layer could lead to cascading effects on benthic and pelagic ecosystems, including habitat compression and community reorganization. We compare these observations to model studies of transport dynamics in the California Current, using an ensemble of passive tracer releases in the Regional Ocean Modeling System (ROMS) to quantify advection and mixing pathways. We also investigate potential changes in source waters to the California Current under climate change scenarios.

3A0.1 ID:5191 INVITED/INVITÉ 08:30

Modelling fish response to climate forcing

Shin-ichi Ito
Tohoku National Fisheries Research Institute
Contact: bill.merryfield@ec.gc.ca

Examples are presented of modeling approaches that investigate the responses of Pacific herring, Japanese sardine, and Pacific saury to climate forcing. For Pacific herring, monthly temperature and zooplankton densities for 1948-2002 from a 3D North Pacific Ecosystem Model were used as input to a herring bioenergetics growth model. For the Japanese sardine model, growth, movement, and survival were simulated with a coupled 3-D hydrodynamics and lower trophic model. For Pacific saury, the model was forced by sea surface temperatures (SSTs) generated by global climate model outputs which contributed to IPCC-AR4. Twelve climate models, which reproduced the Pacific Decadal Oscillation, were selected and B1, A1B, A2 carbon emission scenarios were used. The results from thirty-three ensemble simulations suggest that a SST increase will directly reduce juvenile saury growth and that a prey plankton density decrease will have an influence on the growth and migration patterns of adults, and hence egg production. We are now developing a more general multi-trophic level (end-to-end) marine ecosystem model that includes a super-individual representation of multiple fish species and fishing fleets. This new end-to-end model will be used to investigate and compare climate forcing effects on several contrasting anchovy-sardine systems.

3A0.2 ID:5193 INVITED/INVITÉ 09:15

The impact of increasing greenhouse gases on El Nino/Southern Oscillation (ENSO)

David Battisti
Department of Atmospheric Sciences, University of Washington
Contact: bill.merryfield@ec.gc.ca

TBA

4A0.1 ID:5194 INVITED/INVITÉ 08:30

Submesoscale Phenomena and Dynamics in the North Pacific Ocean

Jim Mcwilliams
Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles (UCLA)
Contact: bill.merryfield@ec.gc.ca

A survey will be given of the principal known submesoscale phenomena and their current dynamical interpretations, such as they are. The phenomena include surface-layer, ageostrophic, and frontal instabilities; coherent vortex formation and dispersal; frontogenesis and filamentary intensification by mesoscale eddy strain fields; current separation from the boundary; and other types of flow-topography interactions. The focus will be on Eastern and Western Boundary Currents. Submeoscale dynamics are important as a contradiction to the expectations of quasigeostrophic dynamics in a rotating, stratified flow, and among its important effects are a forward cascade of energy toward microscale dissipation and diapycnal mixing of tracers.

3B1.5 ID:5195 11:30

HPC at the Canadian Meteorological Centre

Bertrand Denis , *Corbeil Luc*
Environnement Canada
Contact: bertrand.denis@ec.gc.ca

Historically, the accuracy of weather and climate prediction has been highly dependent on computational power. Increasing a model resolution, and consequently the computational demand, has always been a key factor for improving the quality of prediction. Of course, there are other factors that push the demand for higher HPC power. Among them are better and more detailed physical parameterizations, more sophisticated data assimilation systems, emerging numerical applications, and the more than ever popular ensemble prediction paradigm. In order to run these applications in an efficient way, our researchers and developers have always been working hard to improve the numerical methods and to find ways to better adapt and optimize the model code. The IT and facility people have also been part of the overall process, by providing the necessary HPC infrastructure and support.

The presentation will give a broad view of HPC and the related science activities at CMC.

4D2.1 ID:5196 15:30

Preliminary evaluation of the simple agrometeorological indices from the gridded data set(1961 to 2003)

Aston Chipanshi , *Richard Warren* , *Tony Brierley* , *Andrew Davidson* , *Mallory Macdonald* , *Dongzhi Qi*
Agriculture and Agri-Food Canada, Agri-Environment Services Branch
Contact: Aston.Chipanshi@agr.gc.ca

Since the creation of the 10km-gridded climate dataset from the ANUSPLIN software in 2004, there has been a growing demand from the science and end user communities to evaluate simple agrometeorological indices as means of testing the usability of the gridded climate data at the local level. The climate data set at the 10km resolution represents the most comprehensive coverage of high resolution climate data nationally at the present time. As a result, more and more decision support tools such as irrigation calculators, the biomass mapping tool, the environmental health calculator and crop yield models are being built with the gridded data instead of the station data which do not represent local conditions well on account of the sparse station distribution. The agrometetorlogical indices that are calculated from a denser data set also provide a good baseline from which to evaluate how the land resources will change under climate change scenarios.

We calculated simple agrometeorological indices from the gridded data set i.e. the growing degree days (GDDs) an index of energy sufficiency for growing a crop, the difference between Precipitation and Potential Evapotranspiration (P-PE), an index of water sufficiency and the length of the growing season (frost free season) as examples. These indices describe some of the major climatic limitations to agriculture in Canada presently and their representation at a finer scale in map form provides baseline information for the future. We found consistency in the representation of these indices by the gridded data set and other independent data such as the homogenized data set.

3E5.1 ID:5197 16:30

ECO Canada Workshop on Certification for Meteorologists: Professional Meteorologist – P. Met / D'ECO Canada Atelier sur la Certification pour les Météorologuse: Météorologiste professionnel – Mét. P

Grant Trump
ECO Canada
Contact: gtrump@eco.ca

ECO Canada, in collaboration with CMOS and Environment Canada, has recently completed development on National Occupational Standards (NOS) for Meteorology. Created in consultation with over 300 meteorological professionals nation-wide, The NOS for Meteorology forms the basis for a new certification program for Professional Meteorologists (P. Met). In commemoration of its official launch at the 2011 CMOS Congress, ECO Canada is organizing this special session on certification.

This special session will also be conducted in the form of a town hall meeting and discussion panel, involving a number of meteorologists who have been involved in the development of the certification program who will sit as special panelists alongside ECO Canada. This is a great opportunity to learn more about competencies and certification and to ask questions of meteorologists who have been involved in the project.

If you are interested in attending this special workshop or have any questions, please contact Kristina Badrov, Meteorological NOS & Certification project coordinator: kbadrov@eco.ca. We welcome all attendees at the 2011 CMOS Congress.

ECO Canada, en collaboration avec la SCMO et Environnement Canada, a récemment terminé le développement de Normes professionnelles nationales (NPN) pour la météorologie. Créées en consultation avec plus de 300 professionnels en météorologie à travers le pays, les NPN pour la météorologie forment la base d'un nouveau programme de certification pour les Météorologues professionnels (Mét. P). En commémoration de son lancement officiel au congrès de la SCMO 2011, ECO Canada organise cette session spéciale sur la certification.

Cette session spéciale se déroulera comme une assemblée générale et un panel de discussion, avec plusieurs météorologues qui ont participé au développement du programme de certification, et qui agiront à titre de panélistes spéciaux à côté d'ECO Canada. C'est une excellente occasion de mieux découvrir les compétences et la certification, et de poser des questions aux météorologues qui ont participé au projet.

Si vous êtes intéressé à participer à cet atelier spécial ou si vous avez des questions, veuillez communiquer avec Kristina Badrov, coordonnatrice du projet NPN et certification pour la météorologie à : kbadrov@eco.ca. Nous souhaitons la bienvenue à tous les participants du congrès de la SCMO 2011.

3E1.2 ID:5198 17:00

Discussion of the Users' Needs for an Operational High Resolution Deterministic Prediction System / Discussion sur les besoins des utilisateurs pour une système opérationnelle de prévision déterministe a haute résolution

Jason Milbrandt
Environment Canada / Environnement Canada
Contact: jason.milbrandt@ec.gc.ca

Over the past several years, the Canadian Meteorological Centre has run a set of experimental, 2.5-km grid-spacing, limited-area, GEM forecast grids over various regions of Canada. In the near future, the system will be given formal "operational" status and will thus constitute an official CMC forecast product. There is a large number of users of the current system and their needs and applications are varied. In order to most effectively steer research and development of the system, and to help design new configurations that best satisfy the clients' needs within the confines of the computational constraints, current and potential users/clients of the 'GEM-LAM-2.5 system' are invited to participate in this discussion session in order to communicate their specific needs and requests for an operational system.

Depuis déjà plusieurs années, le Centre Météorologique Canadien tourne des grilles à 2,5 km, à domaines limitées sur quelques régions du Canada. Le système obtiendra le statut « opérationnel » sous peu. Il constituera alors un produit de prévision officiel du CMC. Il y a un grand nombre d'utilisateurs du système présent et leurs besoins et applications sont variés. Pour diriger plus effectivement la recherche et le développment du système, et pour aider à créer des configurations qui pourraient mieux accommoder les besoins des clients tout en respectant les limitations computationnelles, les clients présentes et potentiels du système « GEM-LAM-2.5 » sont invités à participer a cette session de discussion pour communiquer leurs besoins spécifiques pour le futurs système opérationnel.

3E4.1 ID:5199 17:00

Ocean Hypoxia Town Hall / Discussion hypoxie dans l'océan

Damian Grundle
University of Victoria
Contact: dgrundle@uvic.ca

Reports of new and expanding areas of oxygen depletion in coastal and oceanic regions are increasing. One of the proposed underlying causes for this increase is climate change. During CMOS 2011, we will be holding a Town Hall Meeting at 5pm on June 8th to discuss this topic and to identify high-level scientific questions related to feedbacks between climate change and ocean hypoxia. This will follow the June 7 CMOS scientific session Ocean Hypoxia: Physical controls, and biogeochemical and ecological responses. The Town Hall discussion will begin by considering recent research and ideas on links between climate change and hypoxia, and will progress towards evaluating the need and urgency for further research, and our capacity in Canada to contribute to this research through inputs from many disciplines, programs and institutions. Organizations contributing to this discussion will include the Pacific Institute for Climate Solutions (PICS), and the VENUS and NEPTUNE Canada ocean observatories. We invite all who are interested in taking part in this discussion to join us.

Plusieurs évidences démontrent que l'accroissement des "zones mortes" (déficitaire en oxygène dissous) dans les régions côtières et océaniques augmente rapidement et que de nouvelles zones mortes apparaissent. Il a été proposé que les changements climatiques pourraient être la cause de cette augmentation. Durant le Congrès SCMO 2011, il y aura une session ouverte le 8 juin, à 5 pm, pour discuter de ce sujet et identifier les questions importantes liées aux mécanismes retroactifs entre les changements climatiques et l'hypoxie dans l'océan. Cette rencontre va suivre la session scientifique SMOS du 7 Juin: Hypoxie dans l'océan: Contrôles physiques et réponses biogéochimiques et écologiques. La discussion va commencer par considérer la recherche récente et les idées sur les liens entre les changements climatiques et l'hypoxie et va progresser vers l'évaluation des besoins, la necessité d'investir davantage dans la recherche et notre capacité de contribuer à cette recherche en collaborant entre plusieurs disciplines, programmes et institutions au Canada. Les organisations qui vont contribuer à cette discussion vont inclure le "Pacific Institute for Climate Solutions" (PICS) et les observatoires océaniques canadiens VENUS et NEPTUNE. Nous invitons tous ceux qui sont intéressés à prendre part à cette discussion.

3E3.1 ID:5200 16:30

NSERC Competition Results and "How to prepare a Discovery Grant application" / Résultats du concours du CRSNG et « Comment préparer une demande de subvention à la découverte »

Kenn Rankine
(Presented by *Dave Bowen*)
NSERC
Contact: abstracts@CMOS.CA

NSERC Research Grants staff will provide an overview of Program news and results of the 2011 Discovery Grants competition. In addition, a workshop will cover the Notification of Intent to Apply (Form 180) process, the Discovery Grant evaluation process (principles, criteria, & ratings), the Conference Model, and tips for preparing a Discovery Grant application. An Evaluation Group member will also be present to share their experience and knowledge of the evaluation process. There will be an opportunity for questions during and after the presentation.

Un membre du personnel de la Direction des subventions de recherche du CRSNG présentera un aperçu des nouvelles du programme ainsi que les résultats du concours 2011. De plus, un atelier portant sur l'Avis d'intention de présenter une demande de subvention à la découverte (formulaire 180), le processus d'évaluation d'une demande (principes, critères, et indicateurs de mérite), le modèle de conférence, et des conseils pour préparer une demande de subvention à la découverte sera offert. Un membre d'un Groupe d'évaluation sera également présent pour partager son expérience et ses connaissances du processus d'évaluation. Il sera possible de poser des questions pendant et après la présentation.

1P205.7 ID:5201 16:00

Transport Analysis of Ozone Enhancement in Southern Ontario during BAQS-Met

Huixia He [1], *David Tarasick* [1], *Junhua Zhang* [1], *Mike Moran* [1], *Paul Makar* [1], *Yves Rochon* [1], *Wayne Hocking* [2], *Michel Bourqui* [3]
[1] Environment Canada
[2] University of Western Ontario
[3] McGill University
Contact: huixia.he@ec.gc.ca

The Border Air-Quality and Meteorology Study (BAQS-Met) was conducted in the Great Lakes region of southwestern Ontario in June and July of 2007 in part to study the ability of the Environment Canada AURAMS (A Unified Regional Air-quality Modeling System) chemical transport model (CTM) to represent regional air pollution in southwestern Ontario, near the U.S.-Canada border. Twice-daily ozonesondes were launched from Harrow, in southwestern Ontario, Canada, during the BAQS-Met field campaign A number of significant ozone enhancements in the troposphere were observed that were the result of stratospheric intrusion events. The observations are compared with results from two Environment Canada numerical models, the operational weather prediction model GEM (used as input to FLEXPART), and a new version of AURAMS, in order to examine the ability

of these models to accurately represent sporadic cross-tropopause ozone transport events. The models appear to reproduce ozone intrusion events with some skill, implying that GEM dynamics (which also drive AURAMS) are able to represent such events well. There are important differences in the quantitative comparison, between the modeled intrusion and that seen in the observations, but it is not clear if this results from errors in some of the trajectories (each intrusion is a sum of many FLEXPART trajectories), from the representation of ozone by PV (Potential Vorticity), or from errors in the actual GEM input fields. However; in particular, the poor vertical resolution of AURAMS around the tropopause causes it to bring down too much ozone in individual intrusions. GEM-FLEXPART calculations indicate that stratospheric ozone intrusions contributed significantly to surface ozone on several occasions during the BAQS-Met campaign and made a moderate but significant contribution to the overall tropospheric ozone budget. These campaign results also suggest that stratospheric intrusions are responsible for much of the variability of ozone in the mid-latitude free troposphere.

1P205.6 ID:5202 16:00

A Stratospheric Ozone Climatology From Global Ozone Soundings and Trajectory Statistics

Jane Liu [1], *David Tarasick* [1], *Vitali Fioletov* [1], *Chris Mclinden* [1], *Guiping Liu* [2], *Christopher Sioris* [1], *Huixia He* [1], *Jinjian Jin* [3]
[1] Environment Canada
[2] University of California at Berkeley
[3] Jet Propulsion Laboratory
Contact: jingxian.liu@ec.gc.ca

An understanding of the stratospheric ozone distribution is a critical step to assess the impact of its variability on climate change. In earlier studies, stratospheric ozone climatologies have been generated in 3-D (latitude, longitude, and altitude) or 4-D (latitude, longitude, altitude, and time) from either satellite data or photochemical models. In this study, a domain-filling trajectory method is explored to generate a global ozone climatology from ozonesonde data. The trajectory technique provides a powerful tool to integrate sparse ozonesonde measurements. The objectives are to create an ozone climatology for model and satellite retrieval a priori, trend analysis, tropospheric-stratospheric exchange research, and ozone-climate interaction studies.

We employ over 45,000 ozone soundings at 116 stations over 44 years (1965-2008) from the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). Forward and back- trajectories are performed for 4 days each from each sounding, driven by NCEP reanalysis data using the HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory Model) from the NOAA Air Resources Laboratory. The resulting global ozone climatology is archived for five decades from 1960s to 2000s with a grid size of 5 by 5 degrees and 1 kilometer vertically.

This climatology dataset is tested at selected stations by comparing the actual ozone sounding profile with that found through the trajectory technique, using the ozone soundings at all the stations except one being tested. The two sets of profiles are in reasonable agreement with maximum differences about 20% in the stratosphere.

This ozone climatology is independent of any photochemical model. It reveals strong longitudinal variation in ozone and covers higher latitudes than current satellite data. We will show results using this data set as the a priori in a photochemical model at Environment Canada. Variability in ozone on seasonal and decadal scales will be discussed.

1P205.5 ID:5203 16:00

Production and Transport of Ozone From Boreal Forest Fires

Jane Liu [1], *David Tarasick* [1], *Mark Parrington* [2], *Paul Palmer* [2], *Huixia He* [1], *Christopher Sioris* [1], *Xiong Liu* [3], *Kevin Strawbridge* [1], *Tom Duck* [4]
[1] Environment Canada
[2] The University of Edinburgh
[3] 3Harvard-Smithsonian Center for Astrophysics
[4] Dalhousie University
Contact: jingxian.liu@ec.gc.ca

In summer 2010, the BORTAS (Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites) mission was planned by several universities and government agencies in the United Kingdom, Canada, and USA. Approximately 200 ozone soundings were made at 13 stations through the BORTAS Intensive Sounding Network, though aircraft measurements were cancelled due to the volcanic eruption in Iceland.

2010 was actually an exceptional year for Canadian boreal fires. We processed satellite MODIS (Moderate Resolution Imaging Spectroradiometer) fire count data and found large fire events in Saskatchewan with peaks in July. Associated with the fires, large amounts of CO (carbon monoxide) are observed in MOPITT (Measurements Of Pollution In The Troposphere) and TES (Tropospheric Emission Spectrometer) satellite data in the middle to upper troposphere. We also found a large amount of NO2, another precursor of ozone, in OMI satellite data. These chemical conditions combined with sunny weather all favour ozone production.

On the days with large fire activity and following days, layers of elevated ozone mixing ratio (>100 ppbv) are observed around 3-5 km at several stations Backtrajectories suggest the elevated ozone in the profile is traceable to the fires in Saskatchewan. This interpretation is supported by satellite observations of CO plumes, by FLEXPART source-receptor modeling, and by GEOS-Chem modeling.

4C1.3 ID:5204 INVITED/INVITÉ 14:30

Decadal Prediction and Predictability

Ben Kirtman
University of Miami
Contact: bill.merryfield@ec.gc.ca

Results are described from a large sample of decadal coupled ocean–atmosphere retrospective forecasts initialized each January and July of 1980, 1985, 1990, 1995, 2000 and 2005 and are compared to predictability estimates given in the seminal papers Boer (2000, 2004, 2010) and Boer and Lampert (2008) . Each hindcast/prediction is run for 10 years and there are six ensemble members for each forecast case. The prediction system is based on the National Center for Atmospheric Research (NCAR) Community Climate System Model version 3 (CCSM3.0) and a state-of-the-art ocean data assimilation system made available by the National Ocean and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory (GFDL). The GFDL ocean data assimilation system uses an ocean component model that is significantly different from the ocean component model in CCSM3.0 in resolution, physical formulation and parameterization. As such, the initialization shock has the potential to significantly impact forecast evolution. This impact is documented. In generating the ensemble members, perturbations are added to the atmospheric initial state only, and thus the experiments are used to examine the loss of predictability associated with small initial atmospheric perturbations. The skill and the predictability of the prediction system (retrospective forecast skill) are analyzed from both a deterministic and a probabilistic perspective with a specific focus in the Indo-Pacific sector. The skill assessment primarily focuses on surface temperature and rainfall.

3P404.1 ID:5205 15:30

Comparing the lower stratospheric temperature trends over the past few decades in CCMVal 2 simulations

Pu Lin , *Qiang Fu*
University of Washington
Contact: plin@atmos.washington.edu

Chemistry Climate Models (CCMs) robustly predicted a stronger Brewer Dobson circulation (BDC) in the future under climate change. However, less attention has been paid to the stratospheric circulation change over the past few decades. Observations show warming over polar region and cooling over tropics since 1979 in Southern Hemisphere, corresponding to a stronger BDC. In this work, we examined the simulations from CCMs for CCMVal-2 REF-B1 (the "reproducing the past" scenario), and compared the simulated trends with observation over the past few decades. We focused on the lower stratospheric temperature patterns as indicators for different processes. We also explored the possible reasons for the large spread among models.

1P308.7 ID:5216 16:00

Meteorological and Oceanographic Support to the Canadian Navy in the North-East Pacific

Dan Roy , *Ulrich Suesser*
Department of National Defence
Contact: daniel.roy5@forces.gc.ca

The Meteorological and Oceanographic Center Esquimalt is an entity of the Canadian Forces established for the purpose of provision of meteorological and oceanographic guidance to military operations. Located in Esquimalt, British Columbia, its primary focus is currently support of naval operations conducted out of the Maritime Forces Pacific, but will soon also include all land and air support activities in British Columbia and the Yukon. MetOc Esquimalt, independently and through projects such as the Spaceborne Oceanographic Intelligence Network (SOIN) is engaged with its east coast MetOc counterpart and other government departments on work designed to improve its capabilities in the areas of diagnosing and prognosticating the state of the oceans, and in the delivery of the MetOc situational awareness picture through evolving technologies.

4D1.2 ID:5218 INVITED/INVITÉ 16:00

Cloud Feedbacks and Global Climate Sensitivity

Kevin Hamilton , *Axel Lauer*
International Pacific Research Center, University of Hawaii
Contact: bill.merryfield@ec.gc.ca

The sensitivity of global mean surface temperature to large-scale climate perturbations depends crucially on how the clouds will respond. Unfortunately clouds are perhaps the one major aspect of

current global model simulations in which we have the least confidence. This talk will begin with a review of some issues in the global model simulation of clouds and cloud feedbacks, and the implications for global climate sensitivity. Then a recent study of cloud feedbacks conducted using the IPRC regional model will be discussed.

4X.1 ID:5219 12:00

Ocean Science Coalition Town Hall Meeting / Séance de discussion ouverte de la coalition des sciences oceanographiques

Adam Monaham And Roberta Hamme
University of Victoria
Contact: monahana@uvic.ca

A coalition of ocean science research universities is seeking to develop a vision for ocean science in Canada and to promote the facilitation of ocean research activities. One method that has been proposed is to commission an expert assessment of ocean sciences in Canada from the Council of Canadian Academies (CCA). The purpose of this town hall meeting is to provide information to the oceanographic community on this effort, to broaden participation in the coalition, and to seek comment on the best methods to achieve these goals.
____ Une coalition d'universités faisant de la recherche en océanographie vise a développer une vision pour les sciences océanographiques au Canada et de promouvoir et faciliter les activités de recherche dans ce domaine. Une méthode qui a été proposée est de commissionner une évaluation des sciences océanographiques au Canada par le Conseil des Académies Canadiennes (CAC). Le but de cette séance de discussion ouverte est de fournir l'information nécessaire à la communauté oceanographique afin de favoriser la participation à cette coalition, et d'obtenir des commentaires afin d'utiliser les meilleures méthodes pour atteindre ces objectifs.

4D4.5 ID:5220 16:30

Training Requirements for Effective Operational Utilization of SAR Winds by the Meteorological Service of Canada

Laurie Neil
MSC
Contact: vladimir.zabeline@ec.gc.ca

With the recent acceptance of synthetic aperture radar wind data for operational use by MSC, opportunities and challenges now present themselves to managers and end users. As with any new dataset, effective training is of paramount importance for ensuring that the benefits of these products are maximized. While most operational users and science staff within MSC have already received some training, continuing advances in the science require that their knowledge be reinforced and updated.

This presentation will provide a brief review of SAR-wind training efforts that have already been carried out, their purpose, and results. It has been found that training is most effective when it focuses on the meteorological processes and atmosphere-ocean interactions that are revealed in these datasets. But as with numerical weather prediction (NWP) models during their early development, SAR Wind outputs are rapidly evolving, becoming more accurate, as well as complex. Users need to understand how the various wind models work in order to determine which model will give the best results in specific circumstances.

The particular importance of providing training for users in SAR Winds will be explained, and a vision of how this might best be carried out in the context of MSC's operational workplace will be suggested. The potential role of the National Laboratories will also be described.

3C5.3 ID:5221 14:00

Field estimates of sonic anemometer angle of attack errors

John Kochendorfer [1], *Tilden Meyers* [1], *Mark Heuer* [1], *John Frank* [2], *William Massman* [2]
[1] ATDD/NOAA
[2] U.S. Forest Service, Fort Collins, CO
Contact: john.kochendorfer@noaa.gov

Sonic anemometer angle of attack or (co)sine errors were estimated for over 100 combinations of angle of attack and wind direction using an RM-Young sonic anemometer and a novel technique to measure the true angle of attack and the wind velocity within the turbulent surface layer. Corrections to the vertical wind speed varied from -5% to 37% for all angles of attack and wind directions examined. When applied to eddy covariance data from two Ameriflux sites, the (co)sine error corrections increased the magnitude of CO2 fluxes, sensible heat fluxes, and latent heat fluxes by ca. 10%. A sonic anemometer designed with one pair of transducers aligned with the vertical axis (Applied Technologies, Inc., "Vx" style) was also tested at four angles of attack. Corrections to the vertical wind speed measured using this anemometer were within ± 1% of zero. Sensible heat fluxes measured using the Applied Technologies anemometer were ca. 9% greater than fluxes of sensible heat fluxes measured using the RM-Young over a grassland, and were ca. 14% larger over a forest. These results indicate that sensors with an off-axis transducer orientation, such as the RM-Young (Fig. 1), Gill, and CSAT anemometers, should be redesigned to allow for measurement of the vertical velocity using one pair of vertically aligned transducers, like the "Vx" style Applied Technologies anemometer.

1P705.3 ID:5222 INVITED/INVITÉ 16:00

Data transfer and data processing for the national AQHI forecast program

David Anselmo
Meteorological Service of Canada
Contact: david.anselmo@ec.gc.ca

The national Air Quality Health Index (AQHI), which was initiated in the summer of 2007, is an information tool that communicates to the Canadian public the total health risk of a mixture of the air pollutants nitrogen dioxide, ground level ozone, and fine particulate matter. As of May 2011, the AQHI forecast program is active in 49 communities across Canada serving more than 90% of the population.

In order to provide hourly observations and twice-daily forecasts of the AQHI to Canadian citizens and numerous other clients (e.g. media, regional partners, and health organizations), a substantial data transfer and data processing infrastructure has been established. This presentation will provide an overview of this system covering all of the essential, interdependent components. On the observation side, these include: the transfer of observations from regional observation networks to the Canadian

Meteorological Centre (CMC) and the generation of observation related products for operational forecasters, Environment Canada's public web site (http://airhealth.ca), the ATADS telephone dissemination service, and regional partners. On the forecast side, these include: the cycling of the Canadian operational air quality forecast model (GEM-MACH15), the integration of other guidance from tools such as the UMOS statistical post-processing system and a surface objective analysis, as well as the generation of forecast products for the forecasters and the public. Additionally, we will present the internal Environment Canada web site that integrates all of these pieces of information into a single resource for forecasters.

The primary objective of this presentation is to provide the AQHI community with a better understanding of the capabilities, challenges, and opportunities of the complex machine that serves as a major technical pillar in the foundation of the national AQHI program.