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

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

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On behalf of all the delegates, the Canadian Meteorological and Oceanographic Society and the American Meteorological Society wish to acknowledge and thank the major supporters of our Joint CMOS-AMS Congress 2012.

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Canadian Meteorological and Oceanographic Society (CMOS)
American Meteorological Society (AMS)

46th CMOS Congress
25th AMS WAF and
21st AMS NWP Annual Meetings
Montreal 2012

May 29th- June 1st 2012

Editor : Sophie Cousineau

PROGRAM

http://www.cmos.ca/congress2012/

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

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NOTES

Internet access: Wireless access to the Internet will be available during the Congress. Locate the Hyatt Regency Montreal network and enter the following password: 401016.

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Welcome from the Premier of Quebec

I am pleased to welcome everyone to Montréal for the Congress of the Canadian Meteorological and Oceanographic Society.

This congress – an opportunity to meet with colleagues from across Canada, the United States and Europe – is also an opportunity to add to the pool of knowledge that underpins the development of research, science and technology in your field. And that is why I salute your presence which attests to your will to be part of the move to hone and continuously improve the services you offer and that benefit people far and wide.

In the fight against climate change and in environmental research, Québec is a recognized leader that redefines initiative. The Changing Environment and its Impact on Climate, Ocean and Weather Services is an inspiring theme for stimulating exchange and discussion given the changes the earth is undergoing.

Bravo to the Canadian Meteorological and Oceanographic Society and the American Meteorological Society for organizing this event.

Best wishes to all for a constructive congress.

Jean Charest

Jean Charest

Québec

Welcome from the Ministre du Développement Durable, de l'Environnement et des Parcs

En offrant à des experts de tous les horizons l'occasion de mettre en commun leurs idées et leurs savoirs, la Société canadienne de météorologie et d'océanographie contribue à améliorer notre compréhension et notre gestion du phénomène des changements climatiques. Nous pouvons ainsi continuer à faire preuve de leadership et adapter ensemble nos habitudes de vie.

Nos objectifs dans le domaine de l'environnement sont ambitieux, et c'est avec confiance que nous envisageons l'avenir, fort du soutien de partenaires de qualité comme vous.

LE MINISTRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DES PARCS,

PIERRE ARCAND

Développement durable, Environnement et Parcs
Québec

Welcome from the Mayor of Montreal

Je suis heureux de souhaiter la bienvenue aux participants du congrès de la Société canadienne de météorologie et d'océanographie 2012 ainsi qu'aux membres de l'American Meteorological Society qui nous font le plaisir de se joindre à eux.

Montréal est une destination toute choisie pour votre réunion puisque notre métropole compte plusieurs institutions majeures qui contribuent à l'enrichissement de la recherche dans les domaines qui vous intéressent.

Vos réflexions peuvent apporter des éclairages essentiels à notre compréhension des phénomènes qui ont et auront un impact majeur sur notre environnement. Soyez donc assurés que vos travaux bénéficieront ici d'une écoute particulièrement attentive. J'espère tout de même qu'ils vous laisseront suffisamment de temps pour découvrir ou redécouvrir une ville qui n'a cessé d'évoluer et de s'embellir au cours des dernièrement années, surtout que vous tenez vos assises justement au cœur du Quartier des spectacles qui a récemment subi une cure de rajeunissement particulièrement visible.

Mes meilleurs vœux de succès accompagnent les organisateurs de cet événement exceptionnel.

À nos visiteurs, je souhaite un excellent séjour et à tous, d'excellentes rencontres et une température agréable!

I am delighted to welcome participants in the 2012 Canadian Meteorological and Oceanographic Society Congress, along with American Meteorological Society members who do us the honour of joining them.

Montréal is an ideal venue for your conference because our metropolis is home to a number of major institutions that conduct research in your fields of interest. Your deliberations can bring fresh insights to our understanding of phenomena that will have a major impact on our environment. We will closely follow your work.

I do hope that you have enough free time, however, to discover or to rediscover a city that has continued to evolve and become even more beautiful over the past few years, particularly as you are meeting right in the heart of our recently and very visibly rejuvenated Quartier des spectacles.

I wish great success to organizers of this exceptional event.

I hope our visitors enjoy a pleasant stay, excellent meetings and great weather!

Gérald Tremblay
Maire de Montréal
Mayor of Montréal

Montréal

A Word About the Societies

CMOS

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

AMS

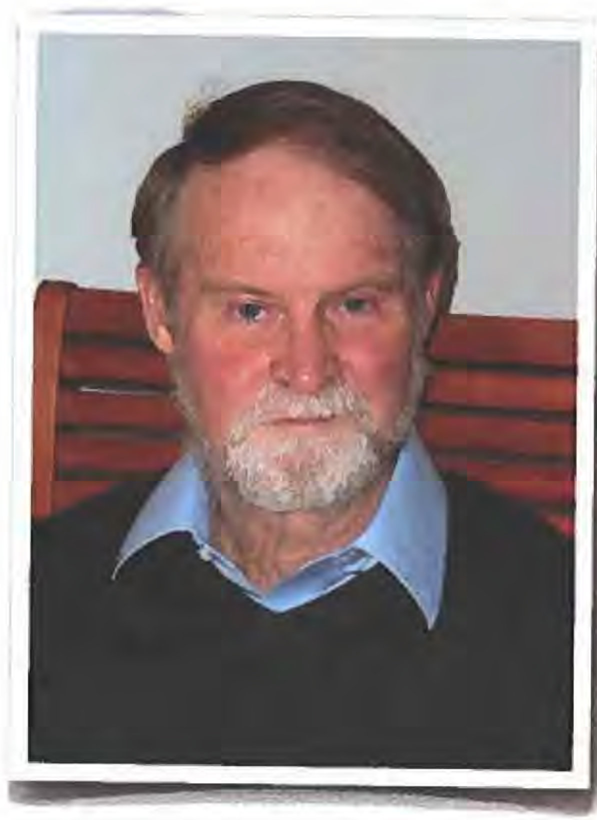
The American Meteorological Society is pleased to be convening this meeting in partnership with the Canadian Meteorological and Oceanographic Society. Our societies have long history collaboration and we are happy to have the opportunity to do so again through this very important scientific meeting. We look forward to a productive and enjoyable conference with our colleagues and friends.

Dr. Louis W. Uccellini, AMS President
Dr. Keith L. Seitter, AMS Executive Director

A Word of Welcome from the Societies and the Committees

Welcome from the President of the CMOS

On behalf of the Canadian Meteorological and Oceanographic Society I welcome you to the 2012 CMOS-AMS Congress under the theme "The Changing Environment and its Impact on Climate, Ocean and Weather Services". This 46th CMOS Congress, held jointly with the 21st AMS Conference on Numerical Weather Prediction and the 25th AMS Conference on Weather Analysis and Forecasting, promises to be a memorable congress. We extend a warm welcome to participants affiliated with the American Meteorological Society, our partner in this conference. With an exciting scientific program, many exhibitor booths, special events and social activities that celebrate and reward achievement and bring our scientific and professional communities together, there will be many opportunities to engage with friends and colleagues. The Local Arrangements Committee led by Louis Lefaivre and the Scientific Program Committee co-led by Pierre Gauthier and Bruce Telfeyan, have devoted many hours of their time over the last year to organizing the Congress. Their respective teams, along with numerous volunteers, will also be present during the Congress to answer questions and provide assistance if needed.



I encourage all participants in the congress to make room in your schedule for the CMOS annual general meeting, Patterson-Parsons luncheon, banquet, and the public lecture. I hope that CMOS-AMS 2012 will be an exciting and productive experience for all.

Norm McFarlane,
CMOS President

Message from the CMOS/AMS Organising Committees

Welcome to Montreal for the joint meeting of the 46th Canadian Meteorological and Oceanographic Society (CMOS) Congress and the American Meteorological Society (AMS)'s 25th Weather Analysis and Forecasting (WAF)/21st Numerical Weather Prediction (NWP) Conference. This is the first major conference jointly sponsored by the CMOS and the AMS and we are particularly happy to welcome you in the heart of Montreal.

Pierre Gauthier

The joint CMOS/AMS Scientific Program Committee developed the scientific program. More than 550 abstracts were accepted for either oral or poster presentations, in 80 separate sessions, including four joint plenary sessions, and two poster sessions. The congress theme, "The Changing Environment and its Impact on Climate, Ocean and Weather Services", will explore different aspects of weather, climate and oceanic services, which rely on scientific advances in different areas well represented in the program. We are privileged to have excellent plenary speakers who have accepted our invitation to present an overview of current research in different topics in meteorology and oceanography. The session themes also span the extent of meteorological, oceanographic, WAF, and NWP concerns including high impact and severe weather, socio-economic issues, modelling and analysis for weather forecasting and climate studies, and many more areas of research aiming at improving forecasting capabilities.

Bruce Telfeyan

The Local Arrangements Committee has worked hard to make this scientific gathering the most attractive possible. We were especially pleased to organise such an event in collaboration with our Americans colleagues and are looking forward to meet all of you in Montreal. The social events include an icebreaker on the remarkable terrace of the venue and a banquet in the plenary session room. Musicians coming from the Montreal meteorological community will lead these two activities: a Jazz quartet during the icebreaker and a rock band after the banquet.

Louis Lefaivre

A conference like this would not be possible without the efforts of many dedicated people. We would like to thank all the members of the Local Arrangements Committee, the joint CMOS/AMS Scientific Program Committee and the volunteers. It is because of their involvement that we were able to prepare what we hope will be a very successful conference.

We hope you will enjoy your visit in Montreal and take the time to explore this beautiful city.

Regards,

Pierre Gauthier Chair, Scientific Program Program Commitee	Louis Lefaivre Chair, Local Arrangements Committee	R. Bruce Telfeyan Co-Chair, Scientific Committee

Local Arrangements Committee

Louis Lefaivre	Chair of LAC and CMOS Montreal Center Chair
Pierre Gauthier	Chair Scientific Program Committee
Rick Jones	Treasurer
Sophie Cousineau	Registration, Program Book, Logistics
Dominique Paquin	Facilities, IT/AV
Jacques Lavigne	Communications
Richard Harvey	Webmaster
Normand Gagnon	Sponsors
Oscar Koren / Richard Moffet	Exhibits
Nacera Chergui	Teachers' day
Sophie Cousineau / Delphine Person	Volunteer Coordinator
Ian Rutherford	CMOS Executive Director

Scientific Program Committee

Pierre Gauthier University of Quebec at Montreal (Chair)	Bruce Telfeyan US Air Force (co-Chair)
Peter Bartello McGill University	John Gyakum McGill University
Gilbert Brunet Environnement Canada	Denis Gilbert Maurice-Lamontagne Institute
Mark Buehner Environment Canada	René Laprise University of Quebec at Montreal
John Cannon National Weather Service, Gray Maine office	Louis Lefaivre Chair of the LAC
Roger Pierce NOAA Office of Oceanic and Atmospheric Research	Ramon de Elia Ouranos Consortium
Philippe Gachon Environment Canada	Zhaoxia Pu University of Utah
Kevin Scharfenberg NOAA Office of Climate Water and Weather Service	Louis Garand Environment Canada

Volunteers

Charles Anderson	Georges Huard
Alexandra Anderson-Frey	Oleksandr Huziy
Francesco Barbero	Rick Jones
Bessam Bouagila	Dragana Kornic
Kevin Bowley	Dominic Matte
Nathalia Brancher	Oumarou Mikiema
Marc-Olivier Brault	Richard Moffet
Kamel Chikhar	André Monette
Mélissa Cholette	Jean-Philippe Morin
Jacinthe Clavet-Gaumont	Inès Ng Kam Chan
Jean Côté	Danahé Paquin-Ricard
Gérard Croteau	Georgina Paull
Jonathan Doyle	Delphine Person (coordinator)
Pierre Dubreuil	Émilie Poirier
Melissa Gervais	Robert Rabin
Laurent Gosselin	Abhishek Shah
Tanya Graham	Shiliang Shan
Craig Hamm	Sophie Splawinski
Richard Harvey	Kossivi Tete
Richard Verret (photography)	
Local arrangement committee	
to Mario Ouellette for his help and advise in the creation	

Information

Guidelines for Oral Presentations

Please ensure the electronic file name of your presentation follows the following format:

Session number_Abstract number_ Family Name_First Name.

For example: Dominique Paquin is presenting a paper (Abstract #5374) in Session 2B6.5. Her PowerPoint file name should be: *2B6.5_5374_Paquin_Dominique.pptx*.

The Abstract number may be obtained from the abstract list available from the online Conference Calendar (see link on page 3). To access the Conference Calendar please use your contact email address.

Please note that the software used for the conference is Windows 7 with the full Microsoft Office 2010 suite, Quicktime, Adobe Acrobat (PDF), and Adobe Flash. Please ensure that your presentation is compatible with this suite of software.

The presentation files should be self contained – i.e. the use of a browser nor downloading files through the Internet during a presentation is **not** permitted. You must use the conference laptops for the presentation and you will not be able to plug your laptop into the projector. Your presentation files should be uploaded on a central data base with the help of a technician or volunteers in rooms Symphonie 6 and 7 (opened every day 7am to 6pm except for Monday 3pm to 6pm). You may also test your presentation on Laptops provided in that room. Last minute changes are **not** permitted.

The deadline for plenary sessions (8am) is the **evening before**;
Morning sessions (10:30am) 1B 2B 3B 4B **before 7:30am**;
Early afternoon sessions (2pm) 1C 2C 3C 4C **before 8:30am**;
Late afternoon sessions (4:30pm) 1E 2E 3E 4E **before 10:30am**.

Transfers of the presentation files should be done via memory stick (preferred), CD or DVD. SD memory chip is **not** accepted nor is the direct transfer from a compute device such as an iPad or laptop.

Guidelines for Poster Presentations

The Science Posters for the Congress will be located on the Soprano room. Each poster is allocated a maximum space of 42 inches (114cm) wide by 45 inches high (106 cm). The poster boards can accept both Velcro and pins (a supply of both will be available).

There will be 2 poster sessions, each session overlapping 2 days. The **first session** will be held on Tuesday-Wednesday and the **second session** will be held on Thursday and Friday. For the **first session** presentations, posters can be mounted at any time after 3pm on Monday and shall be unmounted Wednesday before 5pm. For the second session presentations, posters can be mounted at any time after 5pm on Wednesday and shall be unmounted Friday before 5pm.

Presenters will be required to be by their posters to discuss their work during the assigned poster session that will be happening during the afternoon health break.

Session Chairs' Guidelines

One assistant will be present in each session room. The assistant will be available to help with any A/V or computer technical problem. Each computer will be equipped with the following software: Windows 7 with the full Microsoft Office 2010 suite, Quicktime, Adobe Acrobat (PDF), and Adobe Flash.

Before the session starts, the chairperson should:

- touch base with the assistant;
- check if all talks are available on the computer;
- verify that the person to speak is listed in the program as the presenter, or one of the authors, or otherwise is sufficiently acquainted with the work in order to answer questions.

The chairperson is responsible for opening and closing the session on time. The time allocated for a presentation includes the time for questions and discussions as well as the changeover to the following presenter. In consideration of many parallel sessions, the time schedule of the session should be strictly kept. A timer will be available in each session room.

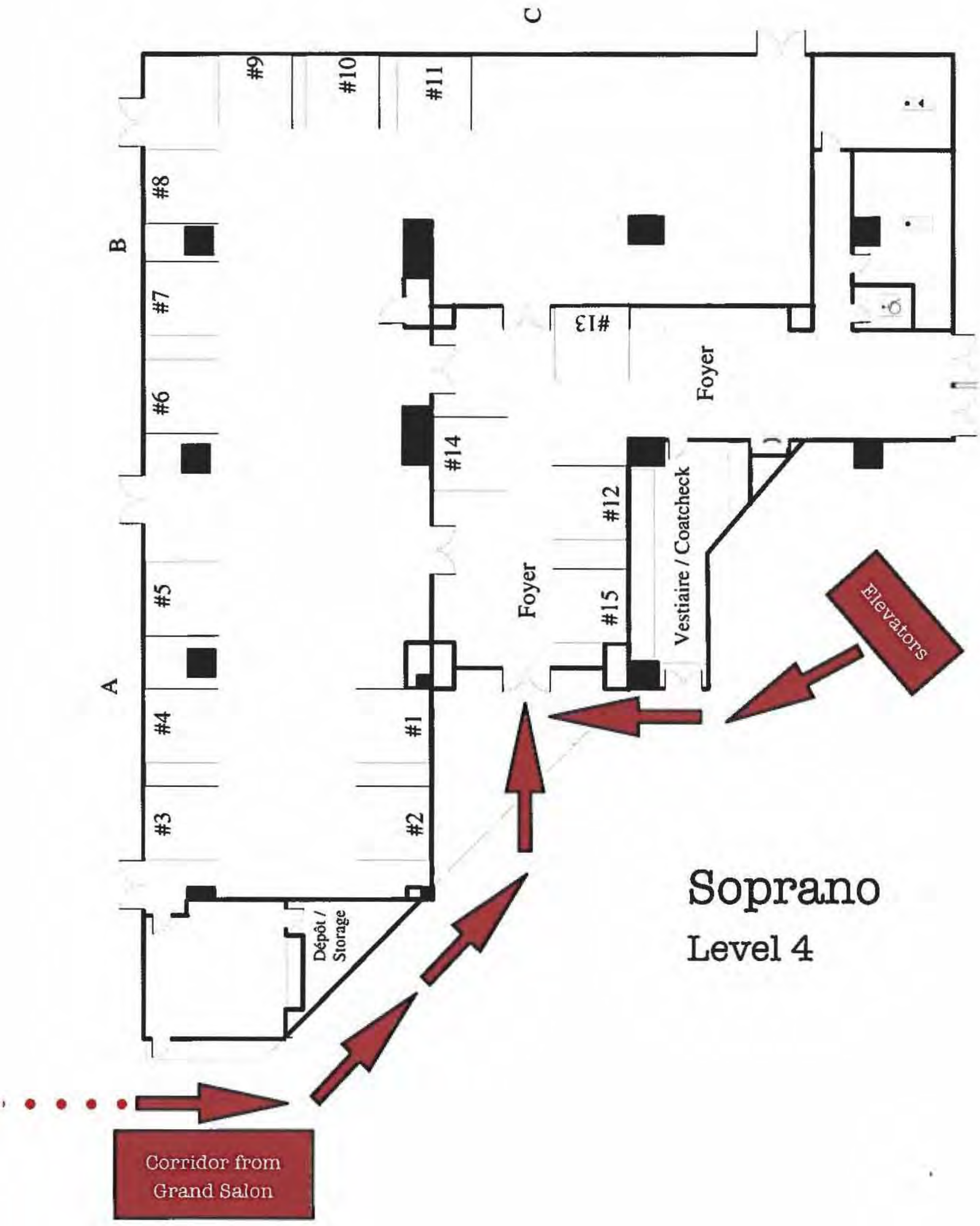
Should an unforeseen gap in the schedule appear, it should be filled with a standby paper, an extended question period on previous talks or a short description of the poster sessions associated with the session.

The updated session program will be shown outside of the session room well before the session starts. The chairperson will receive a copy from the assistant.

Exhibitors List

Exhibitors	Web link	Booth
Soprano A		
JouBeh Technologies Inc.	www.joubeh.com	1
Geneq Inc.	www.geneq.com	2
Environnement Canada	www.ec.gc.ca	3
Info-Electronics Systems Inc	www.info-electronics.com	4
Campbell Scientific Canada Corp	www.campbellsci.ca	5
Soprano B		
ASL Environmental Sciences	www.aslenv.com	6
Hoskin Scientific Ltd	www.hoskin.ca	7
Vaisala Inc	www.vaisala.com	8
ATS Technology Systems Inc	www.atstechnology.ca	9
Belfort Instrument Company	www.belfortinstrument.com	10
Geonor Inc	www.geonor.com	11
Foyer of Soprano A, B and C		
ECO Canada	www.eco.ca	12
COMET	comet.ucar.edu	13
AXYS Technologies Inc	www.axystechnologies.com	14
Canadian Meteorological and Oceanographic Society	www.cmos.ca	15

Exhibitors and Posters Session Floor Plan



Social Agenda

Icebreaker

Simon Pellerin an
Mark Buehner

The Congress "Icebreaker" will be held on Monday evening, May 28th between 5:30pm and 10pm. The venue will be the Inspiration room and on the beautiful Terrasse on the level 6 floor of the Hyatt Regency hotel. Refreshments will be available, and hot and cold canapés will be served throughout the evening. Areas will be available for mingling, for listening to live jazz and for quiet conversation with colleagues and friends. Music will be provided in by a Jazz Quartet from Montreal of which two members are meteorologists.

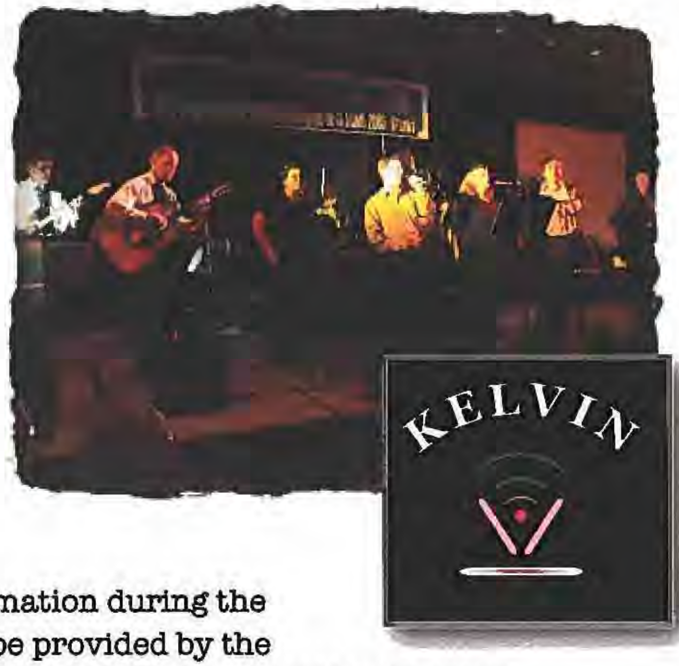
Thierry Doré

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

Student night

Students are invited to a gathering at the Sainte-Élizabeth European Pub on Tuesday May 29th, a few blocks from the Hyatt Regency hotel.

Banquet



Awards banquet will be held on Thursday evening in the Grand Salon Opéra starting with a cash bar at 6:30pm in the Foyer of the Grand Salon Opéra. Each full-congress registrant will be provided a ticket to the Banquet. EXTRA tickets for guests can be purchased during on-line registration. A few extra tickets will be available for last-minute purchase at the Congress registration desk but availability may be limited. Animation during the evening will follow the Banquet and will be provided by the Kelvin band. Kelvin is a group of twelve amateur musicians, including four singers, working for Environment Canada in Montreal: at the Canadian Meteorological Centre (CMC), at Ouranos and at the Biosphere. The groups' history is intimately connected with CMOS, as it was at the Ottawa conference in 1994 that four CMC attendees, musicians themselves, had the idea of forming a musical group at the CMC. In the beginning, they saw this as an excellent recreational pursuit and as an activity for the CMC Christmas Party. Since that time, other amateur musicians have joined the band, while others left. The enthusiasm of the band members, along with a good deal of practice, has raised the musical quality of the group, and considerably enriched its repertoire. In recent years the band has given numerous concerts for various associations and organizations related to the environment. Many conference participants will remember the Kelvin shows from the banquets at the CMOS conferences in 1999 (Montreal), 2002 (Rimouski), and 2003 (Ottawa).

Patterson-Parsons Luncheon

At noon on Wednesday May 30th, CMOS will host the Patterson-Parsons Luncheon in the Grand Salon Opera. The Patterson Distinguished Service Medal is presented annually by the Meteorological Service of Canada for distinguished service to meteorology in Canada. The Timothy R. Parsons Award for Excellence in Ocean Sciences is awarded annually by Fisheries and Oceans Canada to recognize a Canadian scientist for outstanding lifetime contributions to multidisciplinary facets of ocean sciences or for a recent exceptional achievement, while working within a Canadian institution.

Student Travel Bursary Recipients

The Scientific committee is pleased to announced recipients of the travel bursary. Thanks to Canadian Meteorological and Oceanography Society and Quebec's Ministère du Développement Durable, de l'Environnement et des Parcs financing these bursary.

Student	University
Aryal, Raju	University of Northern British Columbia
Berg, Stephen	University of Manitoba
Corkum, Matthew B.	York University
Erler, A.R.	University of Toronto
Franklin, Jonathan	Dalhousie University
Islam. Siraj	University of Northern British Columbia
Lagman, Bryan	Dalhousie Universisty
Ma, Zhimin	Memorial University
Shan, Shiliang	Dalhousie Universisty
Wong, May	University of British Columbia

Public Lecture

Oceans and climate change

The oceans play many roles in the climate system of our planet, whose area is 71% covered by them. To date, the oceans have stored about 90% of the additional heat due to increased greenhouse gas emissions linked to human activities. Due to their large thermal inertia, the oceans tend to warm and cool more slowly than the atmosphere when climate disruptions occur. An important fraction of the warming due to greenhouse gas emissions thus remains to come, because several centuries are required before a new thermal equilibrium can be reached between the ocean and atmosphere. A second crucial role played by oceans in the climate system has to do with carbon dioxide absorption. Unfortunately, this carbon sink service performed by the oceans causes a progressive acidification of oceans that could harm some life forms whose exoskeleton is mainly composed of calcareous materials. We deal with these issues by transiting successively from the world ocean to the northwest Atlantic and then to the Gulf of St. Lawrence.

Dr. Denis Gilbert (Fisheries and Oceans Canada, Maurice-Lamontagne Institute) has 20 years experience in ocean climate research. From 2005 to 2010, he led an international working group on the causes and impacts of low dissolved oxygen levels in coastal areas (http://www.scor-int.org/Working_Groups/wg128.htm). He is a member of the National Executive of the Canadian Meteorological and Oceanographic Society (CMOS). He directs the Argo Canada program for the long-term monitoring of global ocean climate using autonomous profiling floats (http://www.argo.ucsd.edu/). He co-authored over 80 scientific publications.

Time & Place: 7:30pm, Wednesday May 30th
Hyatt Regency Montreal - Grand Salon Opera

Teachers' Day

The Canadian Meteorological and Oceanographic Society (CMOS) and the American Meteorological Society (AMS) are pleased to host the Teachers' Day in Montreal on Friday, 1 June 2012. Nine presenters, professionals and researchers will provide teachers with valuable information on various scientific fields. Teachers have an opportunity to experience an engaging and interactive day of educational ideas and activities about meteorology, climatology, oceanography, forecasting, climate change, and so much more! The Teachers' Day 2012 is being held at no charge to the participating teachers.

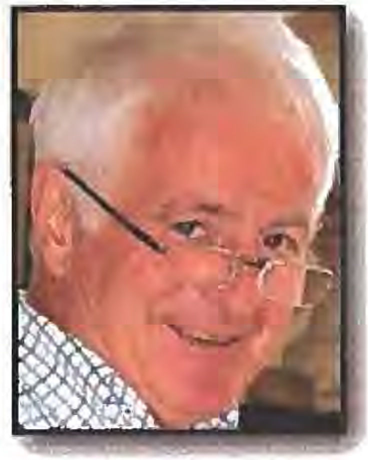
Presenters	Symphonie 4 Level 5	Subject
Martin Bélanger *Manager, Briefing Services, The Weather Network* ***Dorina Surcel-Colan,*** *Meteorological Team Leader, MétéoMédia*	10:45 - 11:10	Weather Changing Climate
René Brunet *Head, Distance Learning*	11:10 - 11:35	Biosphere - Environnement Canada
Richard Moffet *Chief for Special Projects, Canadian Meteorological Centre*	11:35 - 12:00	Environment Canada's seasonal forecast system
Diner		
Dominique Paquin *Specialist in climate simulations at Ouranos consortium*	1:00 - 1:25	Climate Change: a scientific overview
Ivana Popadic *Meteorologist, Enercon Canada*	1:25 - 1:50	Renewable energy: the force of the wind
Jacque Kirouac *Executive Director of Science pour tous* ***Perrine Poisson*** *Project Manager of 24 Heures de sciences*	1:50 - 2:15	24 Hours of Science
David Straub *Professor, Department of Atmospheric and Oceanic Sciences, McGill University*	2:15 - 2:45	Physical Oceanography
Pause		
Valérie Bilodeau *Director of "Les Scientifines"* ***Nora Hamadou,*** *Animator and Project Manager at "Les Scientifines"*	3:00 - 3:25	Les Scientifines

Plenary Speakers

David Grimes, President of WMO

David Grimes was elected President of the World Meteorological Organization by Sixteenth World Meteorological Congress in 2011 for a four-year term beginning immediately after the closure of the Congress. He is also Assistant Deputy Minister and head of Environment Canada's Meteorological Service since July 2006. He has been Canada's Permanent Representative with WMO since December 2006. He has 35 years of scientific, operations, research and management experience at Environment Canada. He has over 20 years experience working with WMO initiatives and programs. His experience also includes a significant number of challenging positions and assignments over the years, ranging from weather forecast operations to science to policy. He occupied the position of Director General with the Meteorological Service of Canada for 15 years for a number of posts, including Canadian Climate Center, Policy, Services, Predictions and Partnerships. Mr. Grimes has extensive educational experience in the domains of science and management (MBA level). He holds a Bachelor of Science in physics, mathematics and meteorology and is a certified professional meteorologist. David Grimes was elected President of the World Meteorological Organization by Sixteenth World Meteorological Congress in 2011 for a four-year term beginning immediately after the closure of the Congress.

Dr. Dave Burridge, ECMWF



Dr. Dave Burridge held the position of Director of the European Centre for Medium-Range Weather Forecasts (ECMWF) from 1991 to 2004. His innovative contributions to the field of numerical weather prediction were a major contribution to the establishment and maintenance of the ECMWF as a world-leading forecast centre. Since retirement from ECMWF in 2004, he has been enthusiastically, and effectively, shaping and steering the implementation of the THORPEX Program. Here his in-depth knowledge of the scientific questions at the forefront of NWP, his ability to assimilate new ideas and look at problems from a number of different angles and his outstanding people management skills have been instrumental in keeping this complex program moving forward. Dr. Burridge was the president of the European Meteorological Society from 2005 to 2008. He was honored by the government of the UK when he was made a Commander of the British Empire (CBE) in 1995 for services to meteorology.

Dr. Gary Lackmann, North Carolina State Universty

Professor of Atmospheric Sciences, North Carolina State University, and Director of Graduate Programs, Department of Marine, Earth, and Atmospheric Sciences.

Originally from Seattle, Washington, Gary Lackmann earned Bachelor of Science and Master of Science degrees in Atmospheric Sciences from the University of Washington in 1986 and 1989, respectively. He worked at NOAA's Pacific Marine Environmental Laboratory and the Naval Postgraduate School before returning to graduate school to earn his doctorate. After completing his Ph.D. in Atmospheric Sciences at the State University of New York, University at Albany, Dr. Lackmann held a postdoctoral position at McGill University before joining the faculty at the State University of New York, College at Brockport in 1996. He joined the faculty of North Carolina State University in 1999. He is the author of a recently published textbook entitled Midlatitude Synoptic Meteorology: Dynamics, Analysis, and Forecasting (published by the American Meteorological Society [AMS] and University of Chicago Press), and he has authored 37 refereed journal publications. He has been a subject-matter editor for the Bulletin of the AMS since 2006, and has served on the governing committees of the UCAR Unidata program since 2004. Professor Lackmann has earned the LeRoy and Elva Martin award for outstanding teaching, and a National Weather Service Collaborative Research award.

Jeffrey K. Lazo, NCAR

Director of the Societal Impacts Program (SIP) at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. He is an economist with extensive experience in nonmarket valuation of environmental and natural resource commodities. His current work focuses on the communication and value of weather information and the economic impact of severe weather events. Jeff is a member of the AMS Commission on the Weather and Climate Enterprise Steering Committee, the World Meteorological Organization Forum on the Socio-Economic Applications of Meteorological and Hydrological Services and WMO's WWRP Societal and Economic Research and Applications Working Group. He is former editor of the American Meteorological Society journal Weather, Society, and Climate. Jeff received a BA in economics and philosophy from the University of Denver and his Masters and PhD in environmental and natural resource economics from the University of Colorado-Boulder. Former positions include Assistant Professor of Mineral Economics at Penn State University and Manager at Stratus Consulting in Boulder, CO.

Dick Dee, ECMWF

Dick Dee is in charge of reanalysis activities at the European Centre for Medium-Range Weather Forecasts (ECMWF). He is responsible for the production of the on-going ERA-Interim reanalysis, and is coordinating European preparations for a new state-of-the-art global atmospheric reanalysis reaching back to the early 20th century. Dr. Dee obtained a degree in Applied Mathematics from New York University in 1983. Prior to joining ECMWF in 2005 he worked as a mathematics professor at PUC-Rio in Brazil, as a research scientist at Delft Hydraulics in the Netherlands, and as a physical scientist at NASA/GSFC in the United States. His primary area of expertise is data assimilation, with special interest in the treatment of biases in models and observations.

Prof. Christian Kummerow Colorado State University

Professor Kummerow joined the CSU Department of Atmospheric Science Faculty in June 2000. Prior to joining the department, he worked at the NASA/ Goddard Space Flight Center serving as the Project Scientist for the Tropical Rainfall Measuring Mission (TRMM). He is currently a member of the Joint TRMM Steering Team. Professor Kummerow is also a member of the Advanced Microwave Scanning Radiometer (AMSR) team and plays an active role in planning and defining new spaceborne missions geared towards obtaining a better understanding of the Global Water and Energy Cycle

Dr. Matthew Martin, Met Office

Dr. Matthew Martin has worked on ocean data assimilation since starting at the Met Office in 2000. Prior to joining the Met Office he completed a PhD in ocean data assimilation at the Department of Mathematics in the University of Reading. In 2008 he became manager of the team responsible for developing the Met Office's marine data assimilation systems. Since joining the Met Office, he has worked on various aspects of the data assimilation. His current work is to lead the implementation and development of a variational ocean data assimilation scheme within the NEMO ocean modelling framework, called NEMOVAR. This scheme is developed in collaboration with ECMWF, CERFACS and other groups. Its implementation will improve the assimilation of data into the ocean forecasting systems used in the Met Office in both the deep ocean (FOAM) and shelf-seas systems, providing more accurate estimates of the ocean state with which to initialize forecasts.

Dr. Marcel Babin, Université Laval

Chairholder CERC in Remote Sensing of Canada's New Arctic Frontier at Université Laval, Québec, Canada, Dr. Babin is an oceanographer with a strong expertise on light propagation and light-matter interactions in the ocean. His research activities cover the study of fundamental lightdriven processes in the ocean (e.g. photosynthesis, photo-oxidation), the optical characterization of various substances found in seawater, the description and understanding of the variations in ocean biomass production, the monitoring of light driven carbon fluxes and biomass production from space using ocean color remote sensing, the development of the related remote sensing algorithms, and the modelling of light-driven processes in the ocean and ecosystem interactions. His research is achieved in the laboratory, in the field and using remote sensing technologies. Part of it is also based on theoretical calculations and modelling. While remote sensing and the related technical developments are central in my research program, his scientific objectives are motivated by fundamental questions on the impact of climate change on marine ecosystems.

Scientific Sessions Description

Renewable Energy – The Important Role of Atmospheric Science

Joël Bédard - Université du Québec à Montréal
Peter Taylor - York University
Contact: bedard.joel@gmail.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 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 atmospheric science 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 the risks related to energy infrastructures. Moreover, environmental modelling 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 and climatology.

Unified modelling systems for weather and climate

Martin Charron - Environment Canada (RPN)
Contact: Martin.Charron@ec.gc.ca

The quality of Earth system predictions and projections on a wide range of space and time scales can benefit from an integrated approach between shorter range numerical weather prediction models and longer range climate models. The objective of this session is to present research activities in the development of unified modelling tools for short-, medium-, and extended-range weather prediction, as well as climate modelling and projections.

The session will focus on the following themes: Unified models for weather and climate applications at the global and regional scales; Low-frequency variability phenomena; Medium- and extended-range forecasting; Seasonal and multi-seasonal forecasting; Atmosphere-ocean-ice coupled systems for weather and climate applications.

AMS Weather Analysis and Forecasting Nowcasting

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

Nowcasting is defined as the precise prediction in time and space of a weather or environmental element starting from time zero and extending up to approximately 6 hours. In Environment Canada nowcasting is expected to form an important component of both the modernized weather warning program and the next generation weather forecasting system. On-going nowcasting research and development projects that are designed to support these future strategies include the Canadian Airport Nowcasting Project, the Science of Nowcasting Olympics Weather for the Vancouver 2010 Winter Olympic Games, the re-development of a SCRIBE-nowcasting system for operational forecasting, the interactive Convective Analysis and Storm Tracking system and the development of a semi-automated Terminal Aerodrome Forecast production system, amongst others. This session will highlight results obtained from these and other projects. In addition talks on future nowcasting strategies, potential future applications, the role and value of instrumentation in nowcasting systems, performance measurement of nowcasting systems, and the integration of nowcasting systems into client decision processes are encouraged.

Atmospheric Remote Sensing of the Arctic

John McConnell - York University
Louis Garand - Environment Canada (RPN)
Tom McElroy - York University
Kaley Walker - University of Toronto
Randall Martin - University of Dalhousie
Norm O'Neill - University of Dalhousie
Contact: jcmcc@yorku.ca

The Arctic is a not a frigid system isolated from the rest of the atmosphere. It is subject to incursions of pollution from Northern industries. It is subject to transport of pollution (gases and smoke) from Boreal forest fires in Canada and Siberia and from agricultural related burning from Europe. It is a harbinger of climate change with rapid multi-year ice depletion. This depletion of the ice will lead to increased ship traffic and increased industry in the search for natural resources, both of which will lead to an increase in air pollution in the Arctic. Surface ozone in the marine boundary layer disappears every spring due to the release of marine BrO and ClOx compunds while 15 km above, the ozone layer is also depleted in the late early spring as a result of anthropogenic chlorine compounds. This session aims to bring together the community to assess our capacity to monitor the Arctic atmosphere remotely from the surface, balloon, aircraft and satellites both LEO (e.g. ACE) and quasi-geostationary (e.g.PCW).

Developments and Applications Environment Canada's High Resolution Deterministic Prediction System

Jason Milbrandt - Environment Canada (RPN)
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. Oral presentations and/or posters are welcome by all members of the community.

Planetary and Exo-Planetary Atmospheres, Surface Interactions and Astrobiology

John Moores, Emily McCullough, Gordon Osinski - University of Western Ontario
Victoria Hipkin - Canadian Space Agency
Michael Daly, James Whiteway, Jack McConnell, Kirill Semeniuk, Victor Fomichev
Stephen Beagley - York University
Carlos Lange - University of Alberta
Kimberly Strong - University of Toronto
Cloud Physics and Severe Weather Research Section, Environment Canada
Contact: john.e.moores@gmail.com

In recent years a great deal of research has been done on Atmospheres around other planetary bodies within our own solar system and beyond. Significant advances have been made using ground and space based telescopes, planetary orbital platforms and landed instrument packages. The techniques involved are varied and range from LiDAR to Spectroscopic methods to Numerical Modelling investigations. However, no matter the technique, the goal is the same: (1) to understand why atmospheres around other bodies possess the physical characteristics that they do today, (2) to understand how those atmospheres have evolved through time, and (3) to understand what the implications are for our own atmosphere and our understanding of it.

Papers are solicited that describe research which addresses any of these three questions. Additionally, since many atmospheres are heavily influenced by interactions with the surface (which may include the presence of biology), papers are also requested which address atmosphere-surface interactions and astrobiological processes which have the ability to influence atmospheric constituents or dynamics.

It is hoped that this session will provide a forum for those members or colleagues of the Canadian Planetary Science Community who specialize in or whose work involves atmospheric science. With several recent and upcoming projects, including the Phoenix Mars Lander LiDAR and MET Station as well as the planned MATMOS instrument onboard Mars Trace Gas Orbiter, this is a community that is growing.

Science in support of air quality management

Robert Nissen - Meteorological Service of Canada
Xin Qiu - Novus Environmental Inc.
Contact: robert.nissen@ec.gc.ca

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. This Session integrates the various themes we have considered. It emphasizes the common goals and needs of the various themes, while specifying four goals: 1.Real-time event analysis 2.Assimilation of observations for air-quality forecasting 3.Assessment of local and long-range pollutant transport 4.Informing the public and the health sector about air quality in real-time or near-real-time. We welcome your presentation on the aspects, but not limited to better understand, forecast, and manage air pollution as we understand there is a need to bring together information about a variety of atmospheric constituents from different observational platforms (surface monitoring networks, satellites, sondes, ground-based remote sensors, aircraft, ...), about nonlinear chemical and physical atmospheric processes from meteorological and chemical transport models; about emissions and emissions-generating activities and population demographics, exposure-related behaviour, and health impacts.

Biomass Burning Smoke Plumes: Atmospheric Impacts, Detection, and Prediction

David Waugh - Meteorological Service of Canada
Sylvie Gravel - Environment Canada
Contact: david.waugh@ec.gc.ca

Biomass burning can be a dominant disturbance regime and is responsible for modifying landscape diversity, influencing energy flow and global atmospheric chemistry. Biomass burning is also a critical process in maintaining populations of many boreal forest species. Research into the impact of biomass burning has intensified in recent years and awareness has been heightened as a result of the Moscow area fires of 2010 and the devastating Slave Lake, Alberta fire of 2011. Considerable progress has been made in quantifying atmospheric impacts and in the tracking and prediction of smoke plumes. This session will bring together researchers in the disciplines of fire locating, burning emissions, detection and tracking (either by in-situ or remote sensing methods), atmospheric chemistry, modelling and forecasting in our efforts to improve predictive capacity, for the short and long term

Colloquium on Climate services for climate-vulnerable societies

Marc Beauchemin - Environment Canada
Contact: marc.beauchemin@ec.gc.ca

In order to reduce societal vulnerabilities to weather and climate, and to cope with future climate changes, scientific authorities and international organizations have pushed for the development/re-development of climate services. Consequently, databases are increasingly integrated, data is more readily usable, and the service offer is increasingly diversified. But many questions still remain: What does society "really" need climate-wise? What approaches to services give the best results? How do recent changes in our climate affect climate services? Presentations submitted to this session will explore past, actual and future needs for climate services and products in Canada and elsewhere; climate data users and "clients"; the different levels of climate services; communicating climate information; societal perception and understanding of climate information; and the importance of climate services in the face of societal vulnerabilities

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.

Low-frequency variability and predictability

Hai Lin - Meteorological Research Division
Bin Yu - Climate Research Division
Youmin Tang - University of Northern British Columbia
Contact: hai.lin@ec.gc.ca

This session invites contributions that deal with atmospheric variability and predictions on subseasonal, seasonal, 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, tropical-extratropical interaction and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modeling, model inter-comparison, and theoretical approaches are all welcome.

Regional Climate Modelling and Climate Projections

Laxmi Sushama - University of Quebec at Montreal
René Laprise - University of Quebec at Montreal
Anne Frigon - Ouranos Consortium
John Scinocca - CCCma, Environment Canada
Contact: sushama.laxmi@uqam.ca

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

Climate Data Homogenization and Trend Analysis

Lucie Vincent - Environment Canada
Contact: Lucie.Vincent@ec.gc.ca

Long-term and reliable climate datasets are essential for climate change studies. High quality station data with good temporal and spatial resolution are necessary for accurate trend and variability analysis, verification of regional and global climate models, validation of remotely sensed data, and ultimately, the proper detection and attribution of climate change. There remain, however, difficulties for the analysis of these datasets due to observing site modifications or closures, changing observing procedures and instruments, and most recently, downsizing of traditional climate networks along with increasing automation. Techniques have been developed for the identification of "inhomogeneities" in climate datasets due to such non-climatic factors which can seriously interfere with the proper assessment of climate trends. More studies are required for adjusting different climate elements (temperature, precipitation, wind, pressure, humidity, and upper air data) and for different temporal resolutions (annual, monthly, daily, hourly). This session invites contributions describing i) sources of biases in climate datasets related to new instruments, changes in observing procedures, automation and others, and their impact on climate trends; and ii) methodologies for detecting and adjusting inhomogeneities in climate datasets as well as test procedures for evaluation of different methods. Contributions on the development of historical information (metadata) database and use of homogenized data in climate trend and variability studies are also welcome.

Climate change and the carbon cycle

Kirsten Zickfeld - Simon Fraser University
Damon Matthews - Concordia University
Contact: kirsten_zickfeld@sfu.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 the feedbacks between climate and the carbon cycle. 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. We invite submissions on all aspects of the global carbon cycle and its interactions with climate change.

The 11 March 2011 Tohoku (Japan) tsunami: Observations, modelling and lessons for Canada

Josef Cherniawsky, Richard Thomson - Fisheries and Oceans Canada
Contact: Josef.Cherniawsky@dfo-mpo.gc.ca

Over the past decade, the World Ocean has been impacted by three megathrust earthquakes. The 26 December 2004 Indian Ocean earthquake (Mw=9.3), the 27 February 2010 Chile earthquake (Mw=8.8), and the 11 March 2011 Japan (Tohoku) earthquake (Mw=9.0) generated major transoceanic tsunamis that claimed hundreds of thousands of lives and left a legacy of human and economic devastation. Scientific evidence indicates that a similar earthquake will eventually occur along the Cascadia subduction zone (CSZ) off the west coast of North America. The last CSZ earthquake (Mw=9) and tsunami were in 1700 and the probability of another one occurring in the next 50 years is 10-20%. The 2011 Tohoku tsunami was recorded by many coastal, deep ocean, and satellite based sensors, leading to detailed studies of tsunami wave physics and verification of tsunami models. This session will focus on (though is not limited to) the observations and modelling of the 2011 event and on projections of likely impacts of a tsunami on the West Coast from a similar CSZ event.

Operational ice-ocean analysis and prediction

Mark Buehner,Greg Smith - Meteorological Research Division (EC)
Tom Carrieres - Canadian Ice Service (EC)
Greg Flato - Climate Research Division (EC)
Fraser Davidson - Northwest Atlantic Fisheries Centre (DFO)
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 ice-ocean 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.

Coastal Oceanography and Inland Waters

Guoqi Han - Fisheries and Oceans Canada
Jinyu Sheng - Dalhousie University
Ram Rr Yerubandi - Environment Canada
Contact: Guoqi.Han@dfo-mpo.gc.ca

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

Ocean-atmosphere modelling and analysis

Youyu Lu - Bedford Institute of Oceanography
Jianping Gan - Hong Kong University of Science and Technology
Hai Lin - Environment Canada
Contact: Youyu.Lu@dfo-mpo.gc.ca

This session invites presentations of new studies on modelling and analysis of atmosphere and ocean circulation and air-sea interaction processes at broad space and time scales. We welcome abstracts on studies using various ocean-only, atmosphere-only, or coupled models to address the dynamic response to forcing variability, improved parameterizations of air-sea fluxes and sub-grid processes, etc. New methods of analyzing observational and modelling datasets, model validation, inter-comparison and sensitivity simulation studies are also important aspects of this session.

Ecosystem-Based Oceanography

Michael Ott - Fisheries and Oceans Canada,
Contact: Michael.Ott@dfo-mpo.gc.ca

Fisheries and Oceans Canada is moving toward an integrated ecosystem-based approach for fisheries and habitat management. This new approach will require: more complete operational monitoring to better describe the state of ecosystems, their variability, and their natural and anthropogenic stressors; analysis to allow attribution of causes for, and the prediction of, ecosystem change; and the development of tools to project ecosystem information and identify risk factors down to regional and local scales for distribution to stakeholders including managers, industry, and the public. Papers describing current research in any of these areas, as well as management-driven outlines of the types of tools and advice required, are welcome in this session.

Ocean Observation Systems

Michael Ott - Fisheries and Oceans Canada,
Contact: Michael.Ott@dfo-mpo.gc.ca

Integrated Ocean Observation Systems (OOS) are vital to track, predict, manage, and adapt to changes in ocean, coastal, and Great Lakes environments for use in the areas of weather and climate, resource management, natural hazard and pollution, coastal property protection, and scientific research. OOS are comprised of many components, including AUVs, gliders, Argo, cabled observatories, ocean tracking and acoustic tags. Papers describing collaborative efforts and multi-use observation programs are encouraged in this session, as are papers discussing strategic or governance issues.

Acoustics in Oceanography

Len Zedel - Memorial University of Newfoundland
Tetjana Ross - Dalhousie University
Contact: zedel@mun.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.

Atmosphere, Ocean, and Climate Dynamics

Ronald McTaggart-Cowan - Environment Canada
Adam Monahan - University of Victoria
Marek Stastna - University of Waterloo
Mike Waite - University of Waterloo
Contact: ron.mctaggart-cowan@ec.gc.ca

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

Variability in the northwest Atlantic and northeast Pacific, and its relation to atmospheric forcing

William Crawford, Denis Gilbert, Igor Yashayaev - Fisheries and Oceans Canada
Contact: bill.crawford@dfo-mpo.gc.ca

Large scale persistent changes in atmospheric circulation lead to major shifts in ocean circulation patterns and water properties that in turn lead to changes in marine life. The response of the ocean can be quick, in the case of shallow currents, plankton and near-surface life, or decadal and longer for deep sea ocean features such as oxygen concentration, bottom currents and deep water species. Observations and models of this variability will improve our ability to understand and predict changes in marine life that might be linked to atmospheric dynamics. We encourage papers on all aspects of this topic.

Military Meteorology and Oceanography

Martha Anderson - National Defence
Abdoulaye Harou - Environment Canada
Clarke Bedford - National Defence
Marie-France Turcotte - Environment Canada
Contact: Martha.Anderson@forces.gc.ca

This session will provide news on military applications of meteorology and oceanography, including atmospheric modelling, ocean modelling and remote sensing, and program such as the on-going development of the Joint Met Centre at CFB

Gagetown and their intranet-based remote weather briefing capability, and the new forecaster training program for CF Meteorological Technicians.

Risk Communication and Meteorology: Interdisciplinary strategies and approaches to mitigate impacts

Rebecca Wagner - Environment Canada
Contact: rebecca.wagner@ec.gc.ca

Meteorologists produce a variety of forecasts and warnings for Canadians and clients, based on standards and threshold critieria. Many of these standards and critieria are based on science capabilities versus associated impacts based approach. Subsequently, there appears to be a gap between the public perception of performance, verification statistics and the usability of warning messages, which inhibits the receiver from assessing what these messages mean to them. At first glance, the issuance of special weather statements, watches or warnings are fulfilling the duty of providing important information to Canadians to allow them to take appropriate action. This continuum of alerting messages is important especially for key stakeholders in preparing for potential emergencies and response. Further research and public opinion research has shown that the target audience may not be receiving sufficient information to make the best decisions for their safety. This significant gap in information transcends the scope of the science of meteorology and rests in the science of risk communication. This session will explore the current state of risk communication best practices and the future improvements to ensure more informed decision making by emergency managers, health and safety officials, vulnerable communities and individuals.

Use of satellite observations in support of global or regional weather forecasting

Louis Garand - Environnement Canada
Contact: louis.garand@ec.gc.ca

This session welcomes presentations on the use of satellite observations in NWP data assimilation systems (variational, Ensemble Kalman Filter, other). Presentations making use of satellite data for model validation are also welcome. The focus will be on the contribution of satellite observations in relation to key atmospheric variables: temperature, humidity, winds, clouds and precipitation.

Other sessions not described above:

- Advances in verification of forecasts
- Data assimilation and Predictability
- Ensemble prediction
- General NWP-WAF
- Land-surface processes (NWP)
- Overview of operational systems
- Weather case studies
- Operational Weather Prediction Diagnostic Analysis of Weather Systems
- Communicating uncertainty in weather forecasting
- Decision Support Meteorology
- General Weather and Climate Services
- New technologies for weather Services
- Clouds, Aerosols and Radiation
- General Atmospheric Sciences
- General Climate Science
- General Oceanographic Sciences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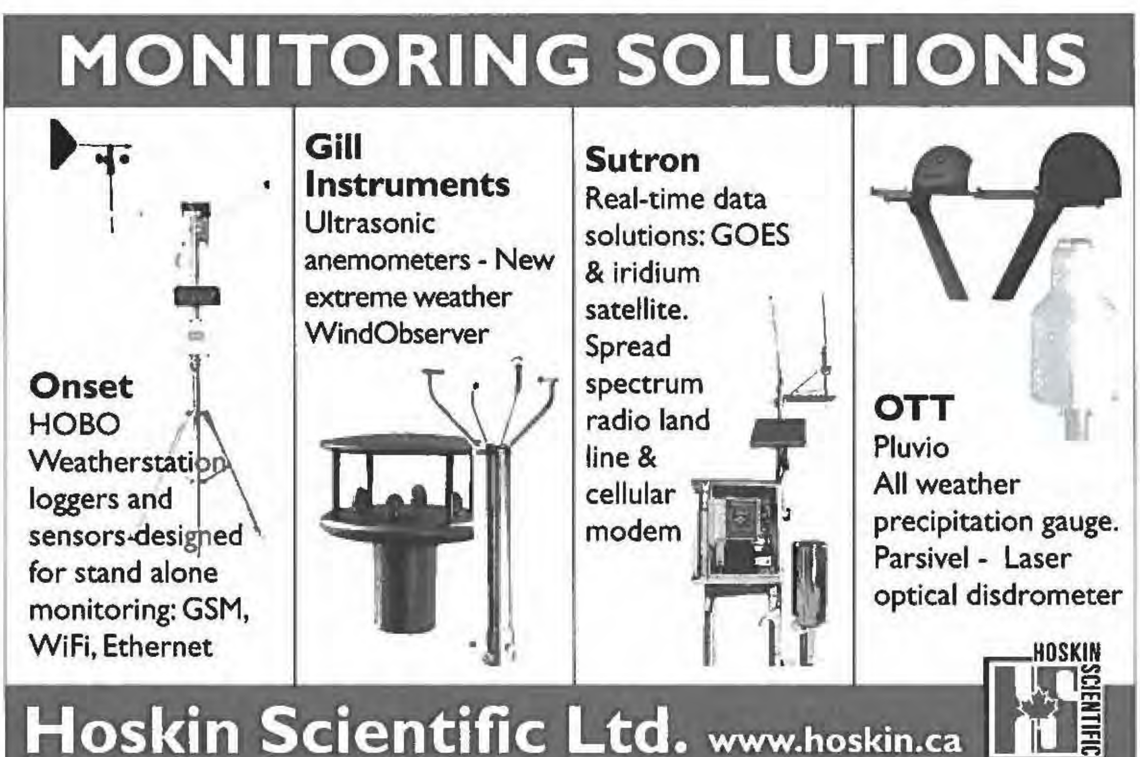
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Monday, May 28th 2012

		Symphonie 1	Symphonie 2B	Symphonie 3A	Symphonie 4B	Inspiration / Terrase
08:00	12:00		CNC SCOR	CMOS Private Sector committee (09:00 - 12:00)	CMOS Publications committee	
13:00	15:00	CONCEPTS-BREA			CMOS University & Professional Education committee	
14:30	16:00			CMOS Council		
16:00	18:00			Annual Meeting of CFCAS Members		
17:30	22:00					ICEBREAKER

Tuesday, May 29th 2012

			Level 4			Level 5					
			Grand Salon Opéra A	Grand Salon Opéra B	Grand Salon Opéra C	Symphonie 1	Symphonie 2	Symphonie 3A	Symphonie 4	Ovation	
	08:30	09:00	Opening ceremonies								
1A	09:00	10:30	Plenary: David Grimes (WMO) David Burridge (ECMWF)								
	10:30	11:00	Health break (Soprano)								
1B	11:00	12:30	Colloquium on Climate Services for vulnerable societies PART 1	AMS-NWP-WAF: Overview of operational systems PART 1	Atmospheric Remote Sensing of the Arctic	General Oceanographic Sciences	General Climate Science				
	12:30	14:00	Lunch								
1C	14:00	15:30	Colloquium on Climate Services for vulnerable societies PART 2	DA I: Ensemble-based Data Assimilation	Operational Weather Prediction (WAF) PART 1	Coastal Oceanography and Inland Waters PART 1	Low-frequency variability and predictability PART 1	Clouds, Aerosols and Radiation	General Atmospheric Sciences	General NWP-WAF PART 1	
1D	15:30	16:30	Health break and Poster session (Soprano)								
1E	16:30	18:00	Colloquium on Climate Services for vulnerable societies PART 3	DA II: Data Assimilation Systems	Operational Weather Prediction (WAF) PART 2	Coastal Oceanography and Inland Waters PART 2	Low-frequency variability and predictability PART 2			General NWP-WAF PART 2	
	18:00	19:30								CMOS general assembly	Students Pub night

			Level 4			Level 5						Level 6	
			Grand Salon Opéra A	Grand Salon Opéra B	Grand Salon Opéra C	Symphonie 1	Symphonie 2	Symphonie 3A	Symphonie 3B	Symphonie 4	Ovation	Création	Inspiration
2A	08:30	10:00	Plenary: Dr. Gary Lackmann (North Carolina State Universty) Jeffrey K. Lazo (NCAR)										
	10:00	10:30	Health break (Soprano)										
2B	10:30	12:00				Coastal Oceanography and Inland Waters PART 3	Climate Data Homogenization and Trend Analysis PART 1	Regional Climate Modelling and Climate Projections PART 1			Advances in verification of forecasts	Atmosphere, Ocean and Climate Dynamics PART 1	AMS-NWP-WAF: Overview of operational systems PART 2
	12:00	14:00	PATTERSON-PARSONS LUNCHON										
2C	14:00	15:30				The Tohoku (Japan) tsunami: Observations, modelling and lessons for Canada	Regional Climate Modelling and Climate Projections PART 2	Climate Change and Extreme Events PART 1	Atmosphere, Ocean and Climate Dynamics PART 2	Military Meteorology and Oceanography	DA III: Data Assimilation Methods	Nowcasting PART 1	General NWP-WAF PART 3
	15:30	16:30	Health break and Poster session (Soprano)										
2E	16:30	18:00	Unified modelling systems for weather and climate (NWP)				Regional Climate Modelling and Climate Projections PART 3	Climate Change and Extreme Events PART 2	*Meeting: Biomass Burning Interest Group (16:00-17:30)*	Communicating uncertainty in weather forecasting and NWP (WAF)	DA IV: Assimilation of Observations	Nowcasting PART 2	
	18:00	19:00						Town Hall NSERC			Town Hall THORPEX 18h00-19h30		
	19:30	21:00	PUBLIC LECTURE: Dr. Denis Gilbert on Oceans and Climate Change										

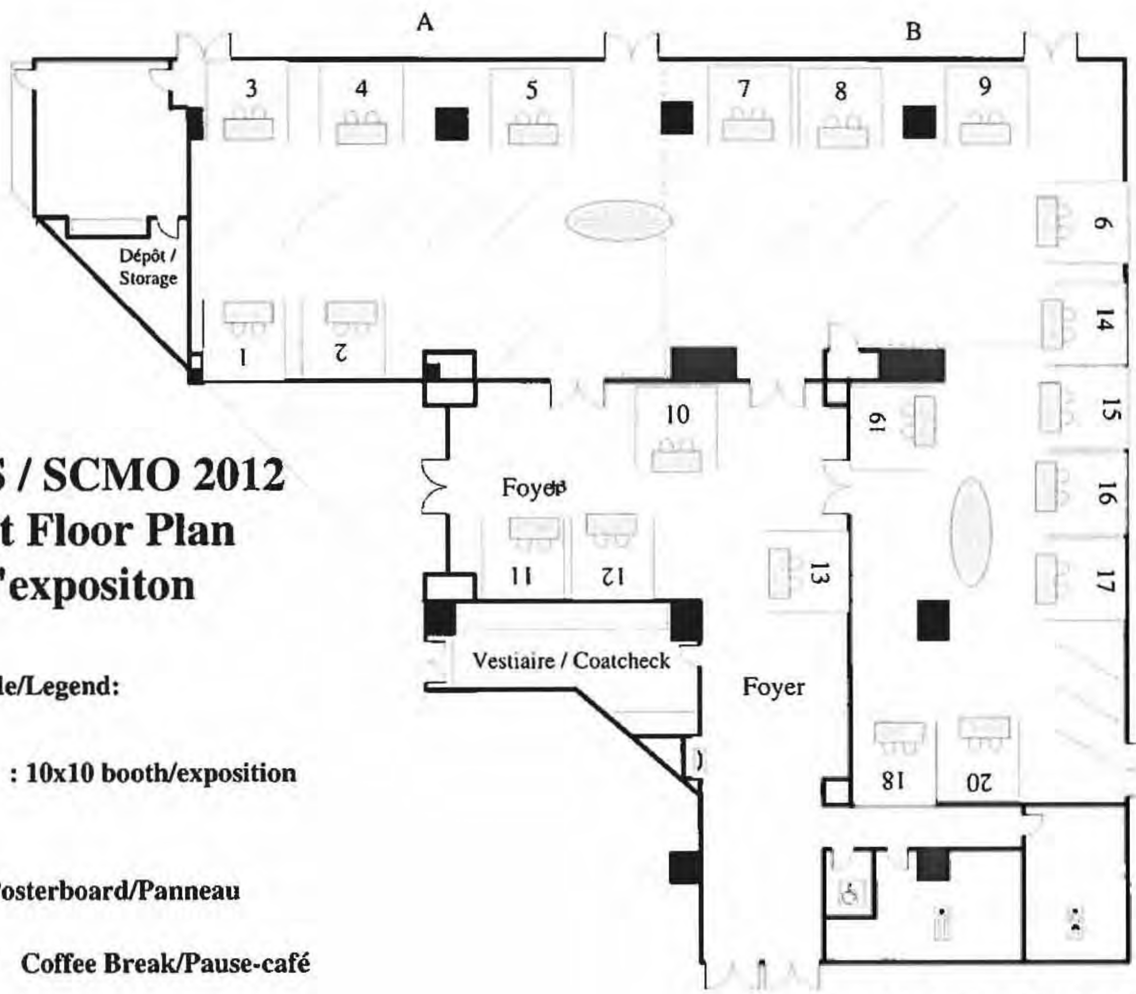
Thursday, May 31th 2012

			Level 4			Level 5					
			Grand Salon Opéra A	Grand Salon Opéra B	Grand Salon Opéra C	Symphonie 1	Symphonie 2	Symphonie 3A	Symphonie 3B	Symphonie 4	Ovation
3A	08:30	10:00	Plenary: Dick Dee (ECMWF) Christian Kummerow (Colorado State University)								
	10:00	10:30	Health break (Soprano)								
3B	10:30	12:00	New technologies for weather Services PART 1	Developments and Applications of High Resolution Prediction Systems PART 1	Regional Climate Modelling and Climate Projections PART 4	Variability in the northwest Atlantic and northeast Pacific, and its relation to atmospheric forcing	Nowcasting PART 3	AMS-NWP-WAF: Overview of operational systems PART 3	Atmosphere, Ocean and Climate Dynamics PART 3	Climate Data Homogenization and Trend Analysis PART 2	
	12:00	14:00	Lunch								
3C	14:00	15:30	DA V: Predictability	Developments and Applications of High Resolution Prediction Systems PART 2	Weather case studies PART 1	New technologies for weather Services PART 2	New technologies for weather Services PART 2	Renewable Energy – The Important Role of Atmospheric Science PART 1			Regional Climate Modelling and Climate Projections PART 5
3D	15:30	16:30	Health break and Poster session (Soprano)								
3E	16:30	18:00				Operational ice-ocean analysis and prediction PART 1	Decision Support Meteorology (WAF)	Climate Change and the Carbon Cycle PART 1	Regional Climate Modelling and Climate Projections PART 6	Ensemble prediction PART 1	Weather case studies PART 2
	18:30	00:00	COCKTAIL and BANQUET								

			Level 4				Level 5				
			Grand Salon Opéra A	Grand Salon Opéra B	Grand Salon Opéra C	Symphonie 1	Symphonie 2	Symphonie 3A	Symphonie 3B	Symphonie 4	Ovation
4A	08:30	10:00	Plenary: Dr. Matthew Martin (Met Office) Dr. Marcel Babin (Université Laval)								
	10:00	10:30	Health break (Soprano)								
4B	10:30	12:00	Ensemble prediction PART 2	Satellite data assimilation in global or regional weather prediction systems (NWP) PART 1	Planetary and Exo-Planetary Atmospheres, Surface Interactions	Ocean-atmosphere modelling and analysis	Biomass Burning Smoke Plumes: Atmospheric Impacts, Detection, and Prediction	Regional Climate Modelling and Climate Projections PART 7	Science Support of Air Quality Management	TEACHERS' DAY	
	12:00	14:00	Lunch								
4C	14:00	15:30	Risk Communication and Meteorology: Interdisciplinary strategies and approaches to mitigate impacts	Satellite data assimilation in global or regional weather prediction systems (NWP) PART 2	Climate Change and the Carbon Cycle PART 2	Ocean Observation Systems	Impacts of Intermittent Natural Plume Emissions: Detection and Prediction				Operational ice-ocean analysis and prediction PART 2
	15:30	16:30	Health break and Poster session (Soprano)								
4E	16:30	18:00	Diagnostic Analysis of Weather Systems	Land-surface processes (NWP)	General Weather and Climate Services	Ecosystem-Based Oceanography			The End		

NOTES

CMOS / SCMO 2012
Exhibit Floor Plan
Plan d'expositon



ALFRED ROULEAU A, B & C

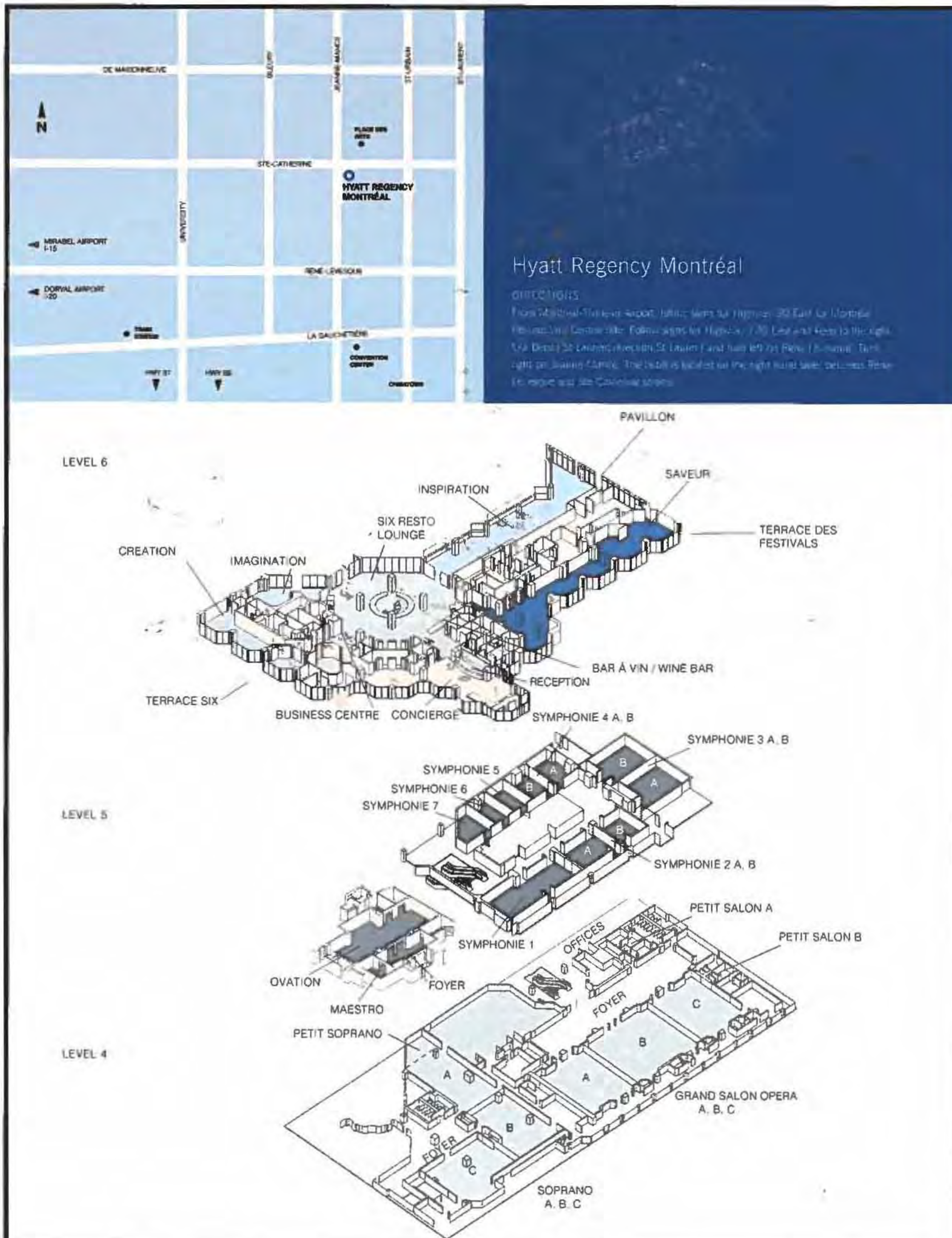
Légende/Legend:

: 10x10 booth/exposition

Posterboard/Panneau

Coffee Break/Pause-café

Hyatt Regency Montreal



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Plenary Day 1 / Plénière jour 1

Room / Endroit (Grand salon), Chair / Président (Pierre Gauthier), Date (29/05/2012), Time / Heure (09:00 - 10:30)

P1.1 ID:5899 INVITED/INVITÉ 09:00

Future of Canada's Meteorological and Hydrological Service

David Grimes
Environment Canada
Contact: david.grimes@ec.gc.ca

The Meteorological Service of Canada (MSC) competitively performs in the top echelon of National Meteorological and Hydrological Services world wide. It monitors the second largest land mass, three adjacent oceans and provides services to one of the most weather and climate affected nations in the world. For over 140 years, the MSC has been an active member of the international weather, climate and water communities.

There are forces that are influencing the priorities and activities of MSC such as support to Canada's northern development, international shipping in Arctic waters and adaptation to variations in climate and extreme weather. Canadians and their institutions are seeking more reliable products and services over longer-term timescales to inform their decisions. World leaders at the 3rd World Climate Conference have called upon the World Meteorological Organization (WMO) to implement a Global Framework for Climate Services (GFCS) which will assist all nations, especially the most vulnerable to improve climate predictions and services.

The resilience of the MSC to changing priorities and fluctuations in funding for over a century is a testament to its people and partners, and a recognition of the value of the services provided to Canadians and their governments. Today, MSC is formulating its 10 year implementation strategy to position its workforce and its investments in science and technology to be responsive to the needs of its citizens through the innovation of skilled scientists and technologists, critical to MSC's success in continuously improving its products and services.

P1.2 ID:6004 INVITED/INVITÉ 09:45

Numerical Weather Prediction: A little history

David Burridge
WMO-THORPEX Program Office
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The development of Numerical Weather Prediction is a real success story and the intellectual capital built up by "heroes" of the 1970s still provides major elements for the numerical treatments of the dynamics employed in current operational forecasting systems.

I shall review some of these historical developments and outline some of the, essentially modelling, challenges facing numerical weather prediction today.

Colloquium on Climate Services for vulnerable

societies PART 1 / Colloque sur les services climatologiques destinés aux sociétés vulnérables PARTIE 1

Room / Endroit (Grand salon A), Chair / Président (Pierre Baril), Date (29/05/2012), Time / Heure (11:00 - 12:30)

1B4.1 ID:6178 INVITED/INVITÉ 11:00

Climate services at the UK Met Office

Carlo Buontempo
UK MetOffice
Contact: abstracts@CMOS.CA

This talk will give the UK Met Office perspective on climate services in response to societal needs. As well as national activities there are also international activities underway, the main one being the Global Framework for Climate Services (GFCS) which arose from the World Climate Conference 3 in 2009 and is being developed now for implementation from the end of the year. The talk will discuss the Met Office's climate service activities, giving concrete examples of some successful services provided to government and industry in the UK and overseas. Time permitting, the talk will also present some of the international activities, including the GFCS, which cover many of the important aspects relevant to climate services, such as observations and monitoring of climate, underpinning research, modelling and prediction, availability of climate information, development of products, user engagement, collaboration, and capacity building.

1B4.2 ID:5934 INVITED/INVITÉ 11:30

Les services climatiques en Afrique

Adama Alhassane Diallo
ACMAD
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La météorologie et le climat ont un impact fort sur les sociétés africaines dont de nombreux secteurs dépendent directement ou indirectement de leur environnement naturel. Les économies, majoritairement basées sur l'agriculture, le pastoralisme et l’exploitation des ressources naturelles sont à la merci des variations climatiques qui sont tour à tour bénéfiques ou génératrices de catastrophes. Plus largement, cette variabilité affecte la problématique de l'eau -marquée par une péjoration continue depuis plus de trois (03) décennies des précipitations et des écoulements des cours d’eau- dont la gestion est un enjeu d'autant plus délicat qu'il traverse les frontières. Certaines calamités, comme le paludisme et la méningite ou l'invasion de d'insectes ravageurs trouvent également dans les conditions climatiques les facteurs de leur développement. A ce contexte naturellement sensible s'ajoute la contrainte du changement climatique. Si des incertitudes persistent concernant certains aspects des projections, il est avéré que le continent devra faire face à des modifications significatives de ses ressources naturelles (écosystèmes, terres, ressources en eau, etc.) toutes choses qui impacteront directement les populations. La prise en compte de ces phénomènes naturels est une nécessité pour les sociétés et les états dont les repères acquis pendant des millénaires et qui ont permis aux sociétés de traverser des siècles ne suffisent plus à offrir les réponses aux interrogations et inquiétudes des populations face à un climat qui évolue trop vite et par la même rendant quasi caduques les instruments, techniques et technologies de parade développés pour s’adapter aux variabilités de climat. Face à cette situation, il est primordial que les décisions à prendre à tous les niveaux

de responsabilité doivent être fondées sur la connaissance objective du contexte météo-climatique à différentes échelles d'espace et de temps. C'est pourquoi des services climatiques adaptés, performants, fiables et réguliers doivent être mis en œuvre. Les centres spécialisés en charge du climat existent au niveau continental, régional et national. Ils fournissent d'ores et déjà des informations utiles pour les populations et les institutions. Néanmoins, des efforts doivent être faits pour hisser ces services au niveau exigé par l'enjeu posé par les conséquences majeures de la contrainte météo-climatique. Le continent s'y prépare avec notamment le programme ClimDev-Africa qui a pour vocation de renforcer les capacités des états à prendre en compte la problématique climatique pour un développement durable des sociétés. Le cadre mondial pour les services climatologiques que l'Organisation Météorologique Mondiale s'efforce de mettre en œuvre au lendemain de la 3ème Conférence mondiale sur le Climat vient à point pour guider et harmoniser ce renforcement. De l'alerte précoce à la planification à long terme, les institutions en charge du climat peuvent également s'appuyer sur les partenariats liés avec les centres mondiaux et autres établissements de recherche pour hausser le niveau technique de leurs prestations.

1B4.3 ID:6176 INVITED/INVITÉ 12:00

Environment Canada's Water and Climate Services

Michel Jean , *Chantale Côté* , *Al Pietromiro* , *Bertrand Denis* , *Greg Flato* , *Jennifer Milton* , *Lesley Obrien* , *Pierre Pellerin* , *Sheferd Marjorie* , *Wallace Al* , *White Russell*
Meteorological Service of Canada (SMC)
Contact: amadouidrissa.bokoye@ec.gc.ca

Nearly all sectors of the society today face challenges associated with climate variability and change. The production and dissemination of timely environmental information to inform planning and operations are key to enable effective adaptation and to provide the capacity to identify the risks and opportunities they present. Advancements in technology, modeling and data assimilation systems have resulted in better and more efficient data collection, processing, forecasting and prediction. Environment Canada (EC) proposes to modernize and refocus the delivery and development of EC water and climate services (WCS) by taking advantage of current and future advancements in science and technology and by developing an effective and coherent service delivery framework.

An overview of the project objectives, scope and key milestones will be presented. The project will define the composition of WCS including the development of a national, coordinated approach to the delivery of climate, impact-based weather and hydrological predictions and projections over a range of timescales. Concerted effort will be required to ensure that interoperability and interdependencies between EC, Other Government Departments (OGD) and the provinces and territories are effective and understood. Furthermore, water and climate issues and the resulting interdependencies are the shared responsibility of many levels of government, the private sector and international bodies. Articulating the role that EC will play amongst these groups is an important component of this project.

AMS-NWP-WAF: Overview of operational systems PART 1 / Survol des systèmes opérationelsPARTIE 1

Room / Endroit (Grand salon B), Chair / Président (R Bruce Telfeyan), Date (29/05/2012), Time / Heure (11:00 - 12:30)

1B1.1 ID:5620 INVITED/INVITÉ 11:00

An Overview of the Current and Future NCEP Operational Modeling Suite

William Lapenta , *Geoff Dimego* , *John Derber* , *Yuejian Zhu* , *Hendrik Tolman* , *Vijay Tallapragada* , *Shrinivas Moorthi* , *Mike Ek* , *Mark Iredell* , *Suru Saha*
NOAA/NCEP/EMC
Contact: bill.lapenta@noaa.gov

The National Centers for Environmental Prediction, Environmental Modeling Center (NCEP/EMC) is developing significant improvements into NCEP's operational forecast systems to increase both the scope and quality of NCEP's products. Ranging from seasonal to interannual prediction and climate reanalysis to hourly rapid updates, NCEP/EMC has advanced the quality of its products and is ready to make further improvements through model enhancements and new computing resources. Forecast advances in global and regional atmospheric systems, real-time ocean and waves, hurricanes, air quality and hydrological applications will be described. Modernization of the NCEP production suite is underway with construction of a software framework compatible with the community-based Earth System Modeling Framework and development of ensemble-based postprocessing techniques for generation of probabilistic products. Work has begun on advanced data assimilation techniques and preparation for the advanced satellite and radar data is in progress. The seminar will provide an overview of the Environmental Modeling Center, a discussion on the current NCEP operational model suite and plans for the future.

1B1.2 ID:5445 11:30

Recent and future changes in the NCEP Global Forecast System

Glenn White [1], *Jordan Alpert* [1], *Hua-lu Pan* [2], *Hui-ya Chuang* [1], *Lidia Cucurull* [3], *John Derber* [1], *Michael Ek* [1], *Shrinivas Moorthi* [1], *Jongil Han* [4], *Daryl Kleist* [1], *Russ Treadon And Others Listed Below* [1], *Fanglin Yang* [2]
(Presented by *Fanglin Yang*)
[1] GCWMB/EMC/NCEP/NWS/NOAA/DOC
[2] IMSG
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Additional authors: David Behringer, Dana Carlis, Dingchen Hou, u-tai Hou, Mark Iredel, Henry Juang, Qingfu Lu, Suranjana Saha, Joseph Sela, Michael Young, and John Ward of GWCMB as well as George Gayno, Kate Howard, Helin Wei and Xingren Wu of ISMG.

The NCEP global forecast system is the center of the NCEP production suite. This presentation reviews major recent improvements and their impacts and discusses future improvements.

In July 2010 the horizontal resolution of the operational GFS increased from approximately 35 to 27 km. Significant changes to the physics included a new planetary boundary layer and new mass flux shallow convection. Precipitation and hurricane forecasts and tropical and mid-latitude forecast skill scores improved quite significantly, but specific problems emerged, including too warm low level summertime temperatures over the western United States, too weak jet level winds and low level winds over the Caribbean, and too weak a QBO.

In May 2011 significant improvements were made to the analysis, including an updated CRTM, and the model physics were modified to correct specific problems, including a new thermal roughness length that decreased the summertime low-level warm bias and decreased background diffusion in the stratosphere, which strengthened the QBO. The change in the thermal roughness length also strengthened low-level winds over land, reducing a negative bias but creating false alarms for strong winds in bias-corrected products.

A major upgrade to the assimilation system is planned for the spring of 2012, when hybrid Ensemble Kalman Filter 3DVar GSI data assimilation will be made operational. Extensive testing indicates very significant improvements to week 1 tropospheric forecasts and substantially improved fits to short-range forecasts to observations. New satellite observations will be introduced into operations.

Future upgrades may include a semi-Lagrangian model with a resolution increase to T1148, improvements to radiation including a new parameterization of sub-grid scale clouds, further improvements to the assimilation, and a coupled analysis-forecast system.

Efforts are being made to emphasize more of a synoptic view and more of a user's perspective of model performance in evaluations of the Global Forecast System.

1B1.3 ID:5835 11:45

Overview of operational NWP systems at the Canadian Meteorological Center

Richard Hogue [1], *André Méthot* [2]
[1] Director, National Prediction Operations, Meteorological Service of Canada, Environment Canada
[2] Director, National Prediction Development, Meteorological Service of Canada, Environment Canada
Contact: richard.hogue@ec.gc.ca

The Meteorological Service of Canada's (MSC)Canadian Meteorological Center(CMC, Dorval) hosts the main R&D activity, technological transfer process and operational 24/7 production environment for the NWP weather and environment forecast suites. Key coordination over the years between Research, Development, Operations and with the IT supercomputing infrastructure have enabled the establishment of an efficient technology transfer process within the CMC. The presentation will review the main operational systems at CMC and will provide an overview of the future improvements to these systems planned in the near term.

The next few years will see significant increase in science and technological capability at a time when the 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. The key linkages between the MSC overall strategic direction and the planned NWP improvements will be presented in particular in the context of the move towards the concept of a MSC next generation forecast system.

1B1.4 ID:5492 INVITED/INVITÉ 12:00

Recent Advancements to the U.S. Navy's Coupled Mesoscale Modeling System

James Doyle And co-authors
Naval Research Laboratory
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A severe winter storm, referred to in the media as Xynthia, crossed Western Europe on 26–28 February 2010 and has been described as the most intense in this region in more than a decade. The violent storm claimed the lives of more than 50 people with many of the deaths in France related to strong winds and a storm surge that caused a rapid rise in water. Hurricane force winds were reported along the Atlantic Coast of France flooding low-lying coastal areas. The storm produced heavy rains, and strong winds, which caused widespread power failures and severely impacted the transportation system including numerous airport closures and delays in rail traffic. The insured losses from the storm are projected to be $2 to $4.1 billion (AIR Worldwide).

In this study, the recently developed adjoint and tangent linear models for the atmospheric portion of the nonhydrostatic Coupled Atmosphere/Ocean Mesoscale Prediction System (COAMPS) are used to explore the mesoscale sensitivity and predictability characteristics associated with the severe extratropical cyclone. Unique aspects of the adjoint modeling system include a full adjoint to the microphysics and a nested grid capability that allows for multi-scale sensitivity calculations. The adjoint is applied using the nesting option with 45 and 15 km meshes for a series of forecasts initialized during the 27-28 February time period. Results indicate that 12 h and 24 h forecasts of intensification of the extratropical cyclone in Western Europe are very sensitive to the initial state. The adjoint-based sensitivity fields indicate highly structured patterns in the wind, thermal, and microphysical fields that project on to the model simulated deep convection, which ultimately influences the intensification rate. Relatively small basic state perturbations based on the adjoint calculations on the order of observational errors (1 m/s, 1 K) lead to rapid growth rates in the near-surface horizontal velocity and deepening rate of the central pressure. The sensitivity of the adjoint results to the horizontal resolution and microphysical parameterization will be discussed. Implications of the adjoint-based sensitivity fields for the predictability of mesoscale aspects of Xynthia will be addressed.

Atmospheric Remote Sensing of the Arctic / Télédétection atmosphérique de l'Actique

Room / Endroit (Grand salon C), Chair / Président (John C. McConnell), Date (29/05/2012), Time / Heure (11:00 - 12:30)

1B8.1 ID:5830 11:00

Multi-year investigation of stratospheric optical depths and extinction coefficient profiles over the Arctic

Auromeet Saha [1], *Norman T. O'Neill* [1], *Glen Lesins* [2], *Christopher E. Sioris* [3], *C. Thomas Mcelroy* [3], *Jason Zou* [4], *Thomas J. Duck* [2]

[1] Université de Sherbrooke

[2] Dalhousie University

[3] York University

[4] University of Toronto

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A multi-year analysis of stratospheric optical depths (SODs) was carried out with the objective of investigating volcanic intrusions and Polar stratospheric clouds (PSCs) in the Arctic. Pan-Arctic “stratospheric-layer” events in CALIOP data were classified into low and high depolarization SODs and these results were analyzed within the context of recent volcanic and PSC events (specifically the Kasatochi, Alaska and Sarychev, Russia volcanos in 2008 and 2009 respectively and the ozone depletion winter of 2010/2011). MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere

Retrieved by Occultation) profiles were also analyzed in order to determine if particle size indicators could be retrieved from the extinction coefficient spectra acquired by this sensor. Preliminary results showing specific event analyses and multi-year climatological interpretations will be presented.

1B8.2 ID:5380 11:15

SATELLITE AND RADIOMETER BASED NOWCASTING APPLICATIONS FOR ARCTIC REGIONS

Ismail Gultepe [1], *Mike Pavolonis* [2], *Victor Chung Chung* [3], *Corey Calvert* [4], *James Gurka* [5], *Randolf Ware* [6], *Louis Garand* [7]

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[2] NOAA/NESDIS, Madison, Wisconsin, USA

[3] Environment Canada, Toronto, Ontario

[4] CIMMS, University of Wisconsin,Madison, Wisconsin, USA

[5] NOAA/NESDIS, Greenbelt, MD, USA

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[7] Data Assimilation and Satellite Meteorology Section, Environment Canada, Dorval, Quebec

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The goals of this presentation are 1) to show the importance of satellite based observations for nowcasting applications with focus on winter Arctic, 2) to improve the nowcasting skills when a PMWR (Profiling MicroWave Radiometer) is used, and 3) to show the importance of surface observations for remote sensing validations over the Arctic regions. Observations from the Fog Remote Sensing and Modeling-Ice Fog (FRAM-IF) project funded by the SAR (Search And Rescue) office which took place near Yellowknife International Airport, NWT, Canada during winter 2010-2011 (Nov 25 to Feb 5) were used in the analysis. Approximately 40 different sensors were used to detect visibility, precipitation and ice particle spectra, and various meteorological parameters. Thermodynamic profiles and ceiling were obtained by a PMWR (Radiometrics MP-3000A) and a ceilometer (Vaisala CL31), respectively. Fog coverage and related visibility parameters were estimated using both GOES and MODIS satellite observations. In this presentation, results from the current work will be discussed and presented for Arctic environments using the context of Polar Communication and Weather (PCW), NPOESS VIIRS (Visible Infrared Imager Radiometer Suite), and GOES-R satellite applications, including nowcasting issues.

1B8.3 ID:5804 11:30

Space Observations of Thin Ice Clouds and Water Vapour in Cold Polar Conditions

Jean-Pierre Blanchet [1], *Alain Royer* [2], *François Châteauneuf* [3], *Tarek Ayash* [4], *Yann Blanchard* [5], *Yacine Bouzid* [1], *Pierre Gauthier* [1], *Norman O'Neill* [2], *Ovidiu Pancrati* [6], *Louis Garand* [7]

[1] UQAM

[2] Université de Sherbrooke

[3] Institut National d'Optique INO

[4] University of Waterloo

[5] CNES/LMD

[6] INO

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The IPY has coincided with the launch, in April 2006, of two major satellites as part of the A-Train constellation: CloudSat and CALIPSO. These active instruments, a space borne cloud radar and a dual frequency lidar, respectively, provided for the first time highly detailed observations on aerosols, thin clouds

and light precipitation. Due to the high polar sun synchronous orbit, reaching 82°N-S of latitude, near the Poles and the frequent overpasses (~ 15 orbits per day), a massive amount of observations has been acquired. First, this paper will summarised our findings on the links between aerosol, thin ice clouds and light precipitation from CloudSat and CALIPSO measurements during IPY and since. Next, following the valuable information on microphysical properties obtained from data analysis, we have developed a new dedicated satellite project with the support of the Canadian Space Agency. The Thin Ice Cloud in Far IR Experiment (TICFIRE) is a dual instrument microsatellite composed of 2 nadir looking radiometers and a limb imager with identical swath of 640 km. The 6 spectral narrow bands between 8 and 50µm allow discriminating critical types of ice clouds and the initiation of precipitation, a key element of the atmospheric water budget. The so called “dirty window” in the far IR spectrum is highly sensitive to water vapour concentration as well. As a legacy of IPY research, the new satellite instrument will provide key information on cloud microphysics, light precipitation and water vapour concentration in otherwise hard to measure conditions.

1B8.4 ID:5351 11:45

Retrieval of aerosol optical depth and plume height from PHEOS FTS NIR radiance spectra and impact of associated precisions on the retrieval of carbon dioxide mixing ratio

Christopher Sioris [1], *John Mcconnell* [1], *Henry Buijs* [2], *Ray Nassar* [3], *Kaley Walker* [4]
(Presented by *Chris Sioris*)
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PHEOS (Polar Highly Elliptical Orbital Science) is a proposed science payload program on the Polar Communications and Weather (PCW) dual-satellite system with 24x7 quasi-stationary viewing of the Arctic and environs from an apogee of ~40,000 km with high spatial and temporal resolution. PHEOS observations will complement those of the operational meteorological imager on PCW. The Weather, Climate and Air Quality (WCA) concept for the PHEOS payload consists of an FTS with 4 bands (in the NIR and thermal IR) at high spectral resolution and a UVS instrument. The spatial resolution for both instruments will be ~10x10 km^2. The WCA objectives are to measure temperature and water vapour profiles and provide information on air quality (gases and aerosols) and greenhouse gases. One important goal for PHEOS-FTS is to measure changes in CO_2 and CH_4 during the day via the NIR over northern mid-latitudes and the Arctic. These GHG data can be assimilated with the Environment Canada Carbon Assimilation System (EC-CAS) to significantly improve estimates of surface fluxes. In order to more accurately estimate fluxes using inversion methods in atmospheric models, it is necessary to measure changes in CO_2 with an accuracy of a few percent or better. One large source of error in the retrieval of CO_2 mixing ratio is due to optical path changes caused by aerosols. The abundance and altitude distribution of the aerosols are factors in determining the changes in photon path length. A retrieval algorithm has been developed to simultaneously measure surface albedo and one piece of aerosol information (optical depth or plume height) from satellite-nadir radiance spectra in the O_2 *A* band. The precisions from this algorithm can be used to assess biases in CO_2 due to the precision of the retrieved aerosol parameter. Different aerosol types are considered such as cirrus and non-conservatively-scattering fine aerosols.

1B8.5 ID:5768 12:00

PCW/PHEMOS-WCA: Quasi-geostationary viewing of the Arctic of the Arctic and

environs for Weather, Climate and Air quality

John Mcconnell [1], *Tom Mcelroy* [1], *Kaley Walker* [2], *Norm O'Neill* [3], *Randall Martin* [4], *Chris Sioris* [1], *Louis Garand* [5], *Ray Nasar* [5], *Henry Buijs* [6], *Stephane Lantagne* [6], *Peyman Rahnama* [7]

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The PHEMOS WCA instruments form a science package planned to accompany the meteorological imager on the PCW mission and they consist of FTS and UVS imaging sounders with viewing range or field of Regard ~ 3400x3400 km2 from near apogee at ~42,000km. The spatial resolution at apogee of each imaging sounder is targeted to be 10×10 km2 or better and the image repeat time is targeted at ~1 hour with a 2 hour threshold. The FTS has 4 bands than span the MIR and NIR. The MIR bands cover 700-1500 cm-1 and 1800-2700 cm-1 with a spectral resolution of 0.25 cm-1 i,e, a similar spectral resolution to IASI. They should provide vertical tropospheric profiles of temperature and water vapour in addition to partial columns of other gases of interest for air quality such as O3, CO, HCN, CH3OH, etc and also CO2 and CH4. The two NIR bands cover 5990-6010 cm-1 (0.25 cm-1) and 13060-13168 cm-1 (0.5 cm-1) and target total columns of CO2 and CH4 and the O2-A band for surface pressure, aerosol OD and albedo. The UVS is an imaging spectrometer that covers the spectral range of 280 – 650 nm with 0.9 nm resolution and targets the tropospheric column densities of O3 and NO2. It is also planned to obtain the tropospheric columns of BrO, SO2, HCHO and (HCO)2 and the aerosol index (AI) as well as stratospheric columns of O3, NO2 and BrO. The quasi-stationary viewing will provide the ability to measure the diurnal behavior of atmospheric properties under the satellites and the ability to provide data for weather forecasting and also chemical data assimilation. One of the important goals for PHEMOS-FTS is to measure changes in CO2 and CH4 throughout the day-lit hours in the NIR near apogee.

1B8.6 ID:5841 12:15

Aerosol and cloud remote sensing over the Arctic: Perspectives for the PHEOS and meteorological imager payloads on the PCW mission

Norman T. O'Neill [1], *Christopher E. Sioris* [2], *John C. Mcconnell* [2], *Randall Martin* [3], *Aurometer Saha* [1], *And The Pheos Team* [1]

(Presented by *Norm O'Neill*)

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The proposed Polar Communications and Weather (PCW) mission will potentially carry the PHEOS (Polar Highly Elliptical Orbital Science) payload along with an operational meteorological imager. Its orbit will be highly elliptical with a substantial geo-synchronous like observing capability directly over the Arctic. Within the context of aerosol and cloud remote sensing, the PHEOS instrumentation suite will include a UVS spectrometer and a Fourier Transform Spectrometer (FTS) O2, A-band channel with a spatial resolution of ~10x10 km2 while the meteorological imager will be a multi-band imager of relatively high spatial resolution with an ABI, MODIS heritage. This instrument suite will provide capabilities for VIS aerosol optical depth (AOD) and UV aerosol index (AI) remote sensing from the UVS and meteorological imager as well as a

degree of aerosol and cloud vertical profiling and AOD retrieval from the FTS A-band. Synergism with active sensors such as the EarthCARE (ATLID) aerosol lidar and the cloud radar (CPR) will provide a degree of unprecedented complementarity for aerosol and cloud retrievals over the Arctic. The presentation will focus on illustrations of validation capabilities for sites such as the PEARL observatory at Eureka Nunavut, the Ny-Ålesund observatory in Spitsbergen and the Barrow observatory in Alaska as well as examples of smoke, pollution, volcanic intrusions and cloud detection over the Arctic region.

General Oceanographic Sciences / L'océanographie en général

Room / Endroit (Symphonie 1), Chair / Président (Arnaud Laurent), Date (29/05/2012), Time / Heure (11:00 - 12:30)

1B5.1 ID:5626 11:00

Large-scale nutrient fronts of the world ocean: impacts on biogeochemistry

Jaime Palter [1], *Irina Marinov* [2], *Jorge Sarmiento* [3], *Nicholas Gruber* [4]
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Several large-scale nutrient fronts span the width of basins. We explore the processes that maintain these fronts and those that act against them. In particular, we investigate the nutrient fronts that ring the subtropical gyres and propose that exchange across these fronts represents a critical pathway for nutrients to enter the gyres. However, these biogeochemical fronts coincide with dynamical fronts or jets, which are often considered barriers to exchange. Therefore, our view of ocean fronts as nutrient gatekeepers must be reconciled with their tendency to act as barriers to exchange. Ekman transport is one mechanism that allows for nutrient transport across the surface of the fronts and is shown to be a leading term in the subtropical nutrient budgets. Ring formation and eddy-driven mixing beneath the core of jets are other mechanisms that can mediate cross-frontal exchange. These mechanisms have intriguing implications for nutrient budgets and their variability.

1B5.2 ID:5547 11:15

Temporal and spatial variability of net phytoplankton growth rates in the North Atlantic: a modelling approach

Laura Bianucci , *Katja Fennel* , *Jann Paul Mattern*
Department of Oceanography, Dalhousie University, Halifax, NS, Canada
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Spring phytoplankton blooms are traditionally explained as a consequence of springtime mixed-layer shoaling and increasing light levels, which lead to positive net growth rates. This view implicitly assumes that there is no net phytoplankton growth in winter, due to deep mixing and low solar radiation. However, observations in the North Atlantic have shown that net growth can be positive well before the onset of spring

stratification. Although specific growth rates are small during winter, net growth is possible if phytoplankton losses are even smaller. One hypothesis suggests that the encounter rate of phytoplankton and their grazers decreases disproportionately in a well-mixed water column, reducing the grazing pressure on phytoplankton. Numerical ecosystem models with constant mortality and maximum growth rates potentially overestimate losses during periods of weak stratification. Our objective is to determine net phytoplankton growth rates in a numerical model so that observed chlorophyll concentrations in the Northwest Atlantic are reproduced. We apply an emulator approach that allows one to determine the temporal evolution of a set of model parameters, such that the model evolves as closely as possible to a given observational dataset (e.g., chlorophyll from SeaWiFS). The chosen parameters are the phytoplankton mortality and maximum growth rates. In this presentation, we will discuss the temporal and spatial variability of these rates and its ecological significance.

1B5.3 ID:5705 11:30

The Impact of Environmental Preference on the Movement and Distribution of Marine Animals

Shiliang Shan , *Keith R. Thompson*
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The motivation for this study is a better understanding of how the American Eel migrates from the coast of North America to the Sargasso Sea as part of its life history. In this exploratory study, we focus on the joint effect of ocean currents and the environmental preferences of marine animals (e.g., specific light level, water temperature) on their overall movement and distribution. We use the Fokker Planck and Backward Kolmogorov equations to model the uncertainty in position forward in time, and also identify possible source regions. The ocean currents are calculated using an idealized (Stommel) model, and also a more complex and realistic eddy- permitting model of the North Atlantic. Animal position is calculated using a particle tracking algorithm modified to include environmental preferences. It is shown that relatively weak motion associated with an environmental preference can have an order one impact on the mean movement and distribution of the animals. The inversion of prescribed flow fields and marine animal distributions for the animals' environmental preferences is discussed.

1B5.4 ID:5623 11:45

Review of Oil Spill Trajectory Modelling in the Presence of Ice

Adam Drozdowski , *S. Nudds* , *C. G. Hannah* , *H. Niu* , *I. Peterson* , *W. Perrie*
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This study is a review of marine oil spill trajectory modelling with a focus on the Arctic environment. The US Geological estimates that the Arctic contains about 20% of the undiscovered, removable, oil and gas resources in the world (USGS, 2008). Increased exploration and production in the Arctic will increase the risk of oil spills from drilling operations, pipelines, and ships. The presence of ice further increases this risk. The primary goals of this review are a synthesis of the state-of-knowledge on oil spill trajectory modelling and the identification of the key gaps in this knowledge as it applies to the Canadian Arctic. The review addresses all the components of a comprehensive oil spill trajectory model including 1) a blowout plume model to determine the distribution of oil in the water column for spills that occur at depth, 2) models for the physical environmental forcing (wind, air temperature, precipitation, ocean currents, sea ice and waves); and 3) an oil fate-and-effects model to address weathering, evaporation, ice-oil interactions, and other details of the oil's interplay with the environment. Novel challenges presented by the Arctic environment include the presence of sea ice, sparse observations of ocean currents and limited ability to monitor the spill's evolution.

The results of the review suggest that there is a significant gap in the integration of these components into a single system that can be used operationally in the event of a spill.

1B5.5 ID:5594 12:00

Simulating the Mixed Layer Depth in the North Pacific Ocean using NEMO

Jennifer Shore , *Michael Stacey* , *Yunfeng Shao*
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NEMO, with spectral nudging incorporated, is used to simulate the circulation of the North Pacific Ocean, from 1975 until 2007. The horizontal spatial resolution is 0.25 degrees and there are 46 unequally spaced vertical levels. The model is forced with NCEP observed monthly winds, sea-surface heat flux and sea-surface pressure. Our specific region of interest is the western Pacific Ocean. Monthly mean time series for the mixed layer depth (MLD) in the Western Pacific have been created using the NEMO model. The modelled MLDs are compared to observations from the same time period. The annual cycle for the MLD in a specific region south of the Kuroshio Extension is well-reproduced.

1B5.6 ID:5603 12:15

Recent Variability in Western Boundary Currents on the Atlantic Slope from Moored Measurments and Altimetry

Yuri Geshelin [1], *John Loder* [1], *Igor Yashayaev* [1], *Guoqi Han* [2], *Miguel Angel Maqueda* [3], *Shane Elipot* [3], *Chris Hughes* [3]
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The structure and variability of low-frequency along-slope flows, temperature and salinity over the Atlantic continental slope during the past 10-15 years are described based on moored measurements complemented by hydrographic surveys and altimetry and coastal sea level observations. The moored measurements were obtained from the ongoing DFO Atlantic Zone Off-Shelf Monitoring Program on the Labrador Slope (since 1995); multi-year deployments in Orphan Basin (2004-10) and Flemish Pass (2002-05), and on Laurentian Fan (2006-07, 2009-11) and the Scotian Slope (2000-08) supported by the PERD Offshore Environmental Factors program and industry; and an ongoing UK Rapid Climate Change program on the Scotian Slope/Rise since 2004. Measurements were made on the 1000- or 1100-m isobath in each region, on the 2000-m isobath in three of the regions, and near-bottom at deeper sites in two of the regions. The structure and variability are interpreted in relation to the equatorward-flowing Labrador and Deep Western Boundary Currents over the NW Atlantic’s continental margin, and perturbations on these flows by Gulf Stream influences and variable atmospheric forcing.

General Climate Science / Les sciences du climat en général

Room / Endroit (Symphonie 2), Chair / Président (Ramon de Elia), Date (29/05/2012), Time / Heure (11:00 - 12:30)

1B6.1 ID:5833 11:00

MSC weather, water and climate monitoring: strategic network planning activities

David Harvey [1], *Eleanor Blackburn* [1], *Alain Pietroniro* [1], *Mike Manore* [1], *Dave Wartman* [1], *Paulin Coulibaly* [2], *Russell Boals* [3]

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MSC operates a number of hydrometeorological (i.e. Weather, Water and Climate) monitoring networks in support of several federal priorities, and often in cooperation with provincial and territorial partners. In 2011, MSC published a Strategic Plan for Hydrometeorological Monitoring in Environment Canada, with a focus of five strategic goals relating to people, core networks, data management, network of networks, and data exploitation.

The implementation of this strategic plan is well underway. This includes the definition of key principles and practices of a Network of Networks; the definition of characteristics of the core networks required to meet MSC mandate; and the definition of the principles of a framework for data collaboration. Furthermore, network evaluation and planning activities are being undertaken to ensure that the networks are meeting the evolving priorities of Environment Canada.

In the case of the national hydrometric monitoring network, three network planning components were initiated in 2011: to review pertinent federal legislation and literature with respect to federal water-related policies, mandates and risk; to review the adequacy of the Canadian hydrometric network in terms of WMO guidelines; and to develop a network design tool for use in optimizing the network.

In the case of the national atmospheric monitoring networks, two major network planning components have been initiated: an assessment of atmospheric monitoring capability relative to the data needs of the MSC's Severe Weather Program; and an assessment of the various technologies and requirements for atmospheric profiling in Canada.

This presentation will provide an overview of these efforts and plans, as well as challenges to transforming the networks to meet current and emerging needs for sound data and information.

1B6.2 ID:5388 11:15

Canadian Science Results from IPY 2007-2008

Tanuja Kulkarni

Aboriginal Affairs and Northern Development Canada

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Fifty-two research projects were supported to investigate critical arctic challenges: climate change impacts and adaptation, and the health and well-being of its communities. The Canadian IPY Final Science Report, to be published as a special issue of the journal Climatic Change, addressed these twin concerns through papers examining important Arctic issue areas, including; the atmosphere and weather, community well-being, human health, marine ecosystems, the cryosphere, oceans, sea-ice, terrestrial ecosystems, and wildlife. This presentation will focus on the overall results from Canadian IPY, including results from investigations on regional, national and international works.

Canadian IPY research projects have advanced Canada's international scientific cooperation, improved the logistical, search and rescue, and research capacities in Northern Canada, and are excellent examples of engaging Northerners and Aboriginal communities in science and research. This work has laid the foundations for continued productive research in the region.

1B6.3 ID:5354 11:30

Scaling analysis of stochastic climate sensitivities

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Climate sensitivity is usually defined as a deterministic quantity relating specific climate forcings and responses. While this definition may be appropriate for evaluating the outputs of (deterministic) GCM's it is problematic when the sensitivities are estimated from empirical data that often have large uncertainties and are best treated stochastically. In this presentation, we statistically define the climate sensitivity as the ratio of RMS temperature to RMS forcing fluctuations, and we evaluate it empirically it as a function of time scale over the range ≈ 30 yrs to 100 kyrs. Since there is only a statistical link between the forcing and response, stochastic sensitivities are only "potential" i.e. they give the correct average sensitivity given that the forcing is dominant. The stochastic sensitivity is thus an upper bound on the deterministic sensitivity. To estimate the sensitivities, we used temperature data, instrumental surface series, multiproxy reconstructions and paleo temperatures; the forcings including several solar, volcanic and orbital forcings. Using Haar wavelet analysis, and with the exception of the orbital forcing, the temperature and forcing fluctuations were found to be roughly scaling so that the climate sensitivity was a power law function of resolution: λ≈Δt**H. We found that the only forcings that are consistent with constant (scale independent, H ≈ 0) feedbacks are the sunspot based solar reconstructions. The volcanic forcing and other solar reconstructions have H ≈ 0.7 implying scaling (hence scale dependent) feedbacks increasing strongly (as a power law) with scale. We show how the neglected scale dependence of the sensitivities has important consequences for evaluating GCM's.

1B6.4 ID:5729 11:45

The Influence of Orbital Precession on the Dynamics of the Stratosphere

Barbara Winter [1], *Esther Haftendorn* [2], *Manoj Joshi* [3], *Michel Bourqui* [1]
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The response to the solar irradiance changes caused by the precession of the equinoxes in a stratosphere-resolving chemistry-climate model (the IGCM-FASTOC) is investigated. In the control climate, perihelion occurs in January and in the perturbed (or paleo) climate, perihelion occurs in July. In the Northern Hemisphere winter stratosphere, the polar vortex response is a weakening in the paleo climate, accompanied by a warm anomaly in the polar lower stratosphere and an increase in the Brewer-Dobson circulation in the lower extratropical stratosphere. In the middle and upper stratosphere, the Brewer-Dobson circulation is weaker, accompanied by a cold anomaly in the high-altitude polar latitudes. In the Southern Hemisphere, the Brewer-Dobson circulation is stronger throughout the stratosphere, accompanied by anomalous warming in high latitudes. The responses in the Brewer-Dobson circulation in each hemisphere

are associated with responses in the vertical flux of Rossby waves out of the troposphere, and responses in land-sea temperature contrasts as well as in storm tracks are proposed as origins for the Rossby wave response.

1B6.5 ID:5828 12:00

A Stratospheric Ozone Climatology From Global Ozone Soundings and Trajectory Statistics

Jane Liu [1], *David Tarasick* [2], *Vitali Fioletov* [2], *Chris Mclinden* [2], *Christopher Sioris* [3], *Jinjian Jin* [4], *Omid Najafabadi* [2], *Guiping Liu* [5]

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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.

Colloquium on Climate Services for vulnerable

societies PART 2 / Colloque sur les services climatologiques destinés aux sociétés vulnérables PARTIE 2

Room / Endroit (Grand salon A), Chair / Président (Jacinthe Lacroix), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C4.1 ID:5986 INVITED/INVITÉ 14:00

L'importance des services climatologiques au sein de la Sécurité civile du Québec

Eric Houde
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La Direction générale de la Sécurité civile et de la sécurité incendie (DGSCSI) est l'organisme chargé de coordonner la réponse du gouvernement du Québec en situation de sinistre, en appui aux municipalités concernées. Au sein des opérations de cette direction générale on retrouve le centre des opérations gouvernementales (COG). Le COG constitue le lieu privilégié de vigie, d'information, d'alerte, de communication et d'opérations du gouvernement en cas de sinistres majeurs. En service jour et nuit, 7 jours sur 7, il dispose de divers produits et services visant la détection, la transmission de l'information, l'alerte et la gestion des situations d'urgence pouvant porter atteinte à la sécurité des personnes, causer des dommages aux biens et menacer l'intégrité des collectivités. Comme au Québec la majorité des sinistres sont liés aux conditions hydrométéorologiques et climatiques, l'importance de services climatologiques fiables, intégrés et pertinents pour nos besoins est essentielle pour une prise de décision efficace et responsable. Par ailleurs, dans l'optique où les aléas météo et climatiques frappent à différentes échelles d'espace et de temps, des services climatologiques adaptés à ces échelles deviennent aussi une nécessité pour permettre à la sécurité civile de planifier autant pour les événements « subits » que pour le plus long terme, notamment en regard d'un climat changeant. Comme organisation de sécurité civile, les services climatologiques sont tout simplement primordiaux, car ils sont au cœur de notre travail de tous les jours et des décisions que nous prenons. Nous saluons donc toute initiative qui favorise un dialogue efficace entre les utilisateurs comme nous et les fournisseurs de ces services si essentiels.

1C4.2 ID:5416 14:30

Issues of Regional Climate Servicing

Hans Von Storch [1], *Francis Zwiers* [2], *Insa Meinke* [1], *Cassbrea Dewis* [2], *Werner Krauss* [1]
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Climate Service brings scientific knowledge of climate and expected climate change into policy and management processes. As such, it has a number of facets. One is the provision of information about climate, climate change and climate impacts (climate atlases, scenario ensembles, reconstructions) in the recent past and in the foreseeable future. Another is about building a dialog between scientific institutions and stakeholders to enable mutual understanding, and a third deals with compiling the present state of knowledge, and the degree of consensus or disensus (kind of mini-IPCC assessments). These tasks are hampered by the special situation in a politicized milieu (some call it post-normal) within which knowledge about climate and climate change forms: While scientific knowledge about present climate change and

expected climate change is well established as mostly consensual in science, other knowledge claims compete for dominance in political decisions in the public. While many scientists believe that this is a problem mostly of insufficiently educated or informed citizens and ill-intended stakeholders, the problem may be related to deeper social dynamics - namely to social and cultural construction processes. Knowledge about the formation and evolution of such alternative knowledge claims, in particular skepticism or alarmism, need to be understood.

Based on experiences of a workshop held in Victoria (BC) in November 2011, the general issues are discussed and illustrated with examples.

1C4.3 ID:5985 14:45

L'UPA et les Services Climatiques

Charles-Félix Ross

Union des producteurs agricoles

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Les conditions climatiques figurent parmi les facteurs prépondérants pour leur influence sur la production agricole, et conséquemment, sur ceux qui en dépendent tout au long de la chaîne agroalimentaire. En effet, la qualité et la quantité des produits de l'agriculture (céréales, maïs, soya, plantes fourragères), de l'horticulture maraîchère et fruitière, de la sylviculture et de l'élevage sont étroitement tributaires des conditions climatiques. Si des outils prévisionnels ont été développés pour plusieurs indices agrométéorologiques incontournables à la production, le principal besoin des agriculteurs, à court terme, consiste à pouvoir accéder facilement auxdits indices, et ce, sur une échelle régionale représentative. À titre d'exemple, Agrométéo Québec1 diffuse des données validées et divers produits agrométéorologiques par l'entremise du site www.agrometeo.org. Il nous apparaît important, dans un premier temps, que les gouvernements fédéral et provincial assurent le financement nécessaire à la consolidation des activités et services développés par cette initiative. Ensuite, considérant que pour l'instant, l'accès à cet outil est limité aux conseillers agricoles, il importe d'en élargir l'accessibilité à l'ensemble des producteurs agricoles et forestiers. À plus long terme, les spécialistes du domaine confirment que nous devrons nous adapter aux changements climatiques. Ainsi, qu'il s'agisse des indices thermiques, hydriques, de ceux liés à l'endurcissement des végétaux, ou encore, de la migration et de la dynamique des mauvaises herbes et ravageurs, les producteurs agricoles et forestiers dépendront de la disponibilité des indices et scénarios agroclimatiques et de leur accessibilité. Plus ces derniers seront précis et fiables et correspondront à l'écosystème agricole et forestier québécois, plus les producteurs seront en mesure de mettre en place des mesures d'adaptation appropriées afin de profiter des opportunités et de se prémunir des effets néfastes potentiels découlant des futurs changements climatiques. Du côté environnemental, l'accroissement d'événements climatiques extrêmes amènera la nécessité de raffiner les modèles prévisionnels afin d'aider les producteurs à déterminer et mettre en place les mesures de mitigation les plus appropriées, par exemple, les aménagements de conservation des sols en situation de pluies torrentielles plus fréquentes.

1C4.4 ID:5708 15:00

Communicating Climate Information to Engineers : The Story of an Iterative Approach

David Huard , *Caroline Larrivée*

Ouranos

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Engineers are increasingly using state-of-the art climate information into the design of infrastructures and for the identification of potential vulnerabilities to climatic phenomena. Acquisition and analysis of climate model output is however still a niche expertise and in casual day-to-day operations, it is unreasonable to

expect engineers to gather and process this type of information.

This project was born with the objective of providing engineers an easy-to-use synthesis of climate information about key climatic variables. The goal is to provide a one- page fact sheet that includes enough information for a decision to be made about the increased or reduced vulnerability of an infrastructure to future climate. Each fact sheet displays historical data from 1950 to 2011, projections from climate simulations for the period 2046— 2065, the statistical distribution of the climatic indicator both for observations and future scenarios, as well as a map of climate analogues to the target region in a future climate scenario.

Successive versions of those fact sheets were presented to four different panels commenting on the content as well as the form. Each time, the panel feedback was used to modify the fact sheet to better fulfill engineers needs and streamline the communication of climate information, leading to substantial modifications to the initial design. The talk discusses this iterative process, draws lessons from this communication experiment and showcases the latest version of these web-based fact sheets.

1C4.5 ID:5988 15:15

Need for updated climatic information, the insurance industry's perspective

Robert Tremblay
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The climate is changing, as extreme rain, snow and wind events are occurring at closer intervals, it materially changes many of risks insured by the home, business and car insurance industry. More than ever, insurers need to continue to provide effective risk transfer tools for the public and businesses. For this, it is imperative to understand the probability of climatic events leading to insured damage to reoccur. Updated IDF tables and future climate models are not only essential for engineers, assets managers and public policy makers, it is also a key input used by the insurance industry to develop risk assessment tools. Tools, like the Municipal Risk Assessment Tool, can assist equally the insurance industry, asset managers and policy makers and support the decision-making leading to the required adaptation of our built environment to our changing climate.

DA I: Ensemble-based Data Assimilation / Assimilation de données basée sur des ensembles

Room / Endroit (Grand salon B), Chair / Président (Herschel L. Mitchell), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C1.1 ID:5551 INVITED/INVITÉ 14:00

Ensemble-Variational data assimilation for global deterministic weather prediction

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A new approach, called Ensemble-Variational data assimilation (En-Var), is tested and compared with the Canadian operational global atmospheric 4D-Var. The En-Var approach relies on the four-dimensional ensemble-based background error covariances produced by the ensemble Kalman filter (EnKF) and a variational minimization to produce a single deterministic analysis. It is well-suited for producing the high-resolution analyses required to initialize global deterministic medium-range forecasts because: 1) it can efficiently assimilate the very large volume of observations currently available, 2) it is more computationally efficient than 4D-Var, and 3) it is more flexible with respect to modelling the background error covariances than traditional EnKF approaches. Preliminary verification results from using En-Var with covariances obtained by averaging the EnKF-based and traditional NMC-method-based covariances will be shown. These results will be compared with those obtained from the standard 4D-Var approach.

1C1.2 ID:5468 14:30

A new configuration of the Ensemble Kalman Filter for the Canadian Global Ensemble Prediction System

Xingxiu Deng [1], *Peter Houtekamer* [2], *Seung-Jong Baek* [3], *Normand Gagnon* [1]
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At the Canadian Meteorological Centre (CMC), the Ensemble Kalman Filter (EnKF) assimilation component provides an ensemble of initial conditions for the Canadian Global Ensemble Prediction System (GEPS). The current operational EnKF with 192 members is run on a horizontal grid of 400x200 (0.9 degrees). With the introduction of a new super computer (IBM Power 7) at the CMC, the horizontal resolution of the EnKF will be increased from 0.9 degree to 0.6 degree (same resolution as for the forecast model of GEPS). The data volume to be assimilated will roughly triple due to a reduced thinning of radiance observations. Meanwhile a new multi-scale algorithm will be used in the EnKF. It is expected that the new algorithm will capture more smaller scale features near the surface, which is beneficial to higher resolution grid settings. Similar changes to the forecast model of GEPS will be included in the forecast step of the EnKF. Results from the new configuration will be presented.

1C1.3 ID:5288 14:45

Model error representation in mesoscale WRF-DART cycling run

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Mesoscale forecasts are strongly influenced by physical processes, from turbulence and mixing in the planetary boundary layer to moist convection and microphysics, that are either poorly resolved or must be parameterized in numerical models. Due to the model errors, mesoscale ensemble systems generally suffer from underdispersiveness which often leads to poor forecast skills. In an ensemble Kalman filter data assimilation, insufficient ensemble spread leads to poor filter performance in the analysis cycle. To alleviate the underestimate of ensemble spread, we compare two approaches to this issue: a multi-physics ensemble, in which each member’s forecast is based on a distinct suite of physical parameterizations, and stochastic backscatter, in which small noise terms are included in the model equations for momentum and potential temperature. We perform our experiments in a domain over the continental U.S. using the

WRF/DART system, which employs the Weather Research and Forecasting model for ensemble forecasts and the Data Assimilation Research Testbed for the ensemble Kalman filter. Verification against independent observations for a one-month summer period shows that including model-error techniques improves not only an ensemble of analyses, but also short-range forecasts started from these analyses. The stochastic backscatter scheme outperforms the multi-physics ensemble near the surface throughout the whole cycling period.

1C1.4 ID:5769 15:00

Potential of an Ensemble Kalman Smoother for stratospheric chemical-dynamical data assimilation

Thomas Milewski
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A new stratospheric Ensemble Kalman Smoother (EnKS) is introduced and the potential of assimilating posterior stratospheric observations to better constrain the whole model state at analysis time is investigated. A set of idealized perfect-twin experiments assimilating synthetic limb-sounding temperature or ozone retrievals are performed with a chemistry-climate model. The performances of an EnKS assimilating observations spread over 48 hours and an EnKF assimilating a denser network of observations are compared with the reference Ensemble Kalman Filter (EnKF). The ozone assimilation with EnKS shows a significant reduction of analysis error for dynamical variables in the upper-troposphere lower-stratosphere (UTLS) region when compared to the reference EnKF. This reduction is similar but slightly smaller than that achieved with the EnKF with denser network. The temperature assimilation with EnKS also significantly decreases the error in the UTLS for the ozone and wind variables, where the EnKF with denser network fails to do so. The temperature (ozone) assimilation with EnKS however significantly degrades the temperature (ozone) variable analyses through the time-lagged auto-covariances. The different analysis impacts from the assimilation of synchronous and asynchronous temperature observations indicate the capacity of time-lagged background error cross-variable covariances to represent (temporal) interactions between variables during the ensemble data assimilation analysis step.

1C1.5 ID:5678 15:15

How to improve the precipitation analysis over North America using the Canadian Atmospheric Regional Ensemble Prediction System ?

Christophe Lavaysse [1], *Marco Carrera* [2], *Peter M.k. Yau* [3], *Vincent Fortin* [2], *Normand Gagnon* [2], *Stephane Belair* [2], *Ronald Frenette* [2], *Martin Charron* [2]
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The aim of this study is to analyze the impact of the Canadian Regional Ensemble Prediction System (REPS) on precipitation forecasts and analyses to provide statistical parameters and uncertainty assessment to the precipitation analysis provided by the Canadian Precipitation Analysis (CaPA) system. The operational version of the CaPA system is coupled to the regional Environment Canada's Numerical Weather Prediction model (GEM) and produce rainfall accumulation at a resolution of 15km. In this study, the operational REPS were used to drive the CaPA system to produce 24h rainfall accumulations at a resolution of 33 km over North America. The spatial interpolation technique is based on statistical interpolation using short range precipitation forecasts from the Canadian Meteorological Centre's (CMC) regional model as the background and rain gauge measurements from the surface network. By using the

REPS to drive CaPA during summer 2010, the influence of the atmospheric perturbations on precipitation analysis products could be analyzed in relation to the deterministic model analysis. An assessment of the uncertainties, associated with the spread of the ensemble analyses will be quantified. Moreover, new methodology tested of the deterministic CaPA will be compared, as using semivariogram or selected observations defined by the ensemble forecast rainfall instead of the deterministic one.

Operational Weather Prediction (WAF) PART 1 / Prévision météorologique opérationnelle (WAF) PARTIE 1

Room / Endroit (Grand salon C), Chair / Président (Kelly Mahoney), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C2.1 ID:5560 14:00

An update from Operations at the Canadian Meteorological Centre

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The Canadian Meteorological Centre (CMC) maintains a fully operational 24/7 production environment that includes data assimilation systems feeding data into various NWP weather and environment forecast models. Along with the requirements of maintaining a 24/7 operational environment, CMC also ensures it can implement a steady stream of systems' improvements. These improvements require careful coordination between EC’s Atmospheric Research groups and CMC’s various development groups before being installed into CMC operations. Increasingly there are additional systems and improvements delivered to CMC from a growing number of partners outside of CMC such as MSC's national labs for example.

A review will be made of the main implementation highlights of the past year, including:

- Improvements to the Global Deterministic Prediction System (GDPS), to the Regional Deterministic Prediction System (RDPS) and the Global Ensemble Prediction System (GEPS); - Details of the experimental Regional Ensemble Prediction System (REPS) and the SCRIBE now-casting systems becoming operational; - The technical transfer from CCCma to CMC of a state of the art coupled inter-seasonal prediction system called CanSIPS (Canadian Seasonal to Inter-annual Prediction System); - Updates to the air quality model GEM_MACH15.

Planned improvements for the coming year will also be presented and include, in part:

- Completion of the migration to a new super-computer; - Updates to the wave model (WAM 4.5.1); - Implementing an experimental ozone surface analysis; - Increasing the resolution of the Regional Deterministic prediction System (RDPS) to 10 km and adding 4D-Var to this system; - Consequently, appropriate updates will follow to the Gulf-of-St-Lawrence coupled model, to GEM-MACH and to other systems downstream from the RDPS system; - Increasing the resolution of the Global Deterministic Prediction System (GDPS) to 25 km (and updating to version 4 of GEM(that uses staggered vertical coordinates)); - Implementing an experimental global sea-ice analysis; - Making dew point temperatures (Td) from UMOS operational; - Adding to the GEPS system a monthly forecast component; - Various updates to the GEPS and REPS systems; - Making Updates to the SCRIBE now-cast and to the Canadian Precipitation Analysis (CaPA - RDPA) systems; - Including additional satellite datasets to the assimilation systems; - Implementing experimental land and surface forecast and assimilation systems; - And more...

1C2.2 ID:5714 14:15

Progress on FIM development toward membership in the North American Ensemble Forecast System

John Brown [1], *Stan Benjamin* [1], *Rainer Bleck* [2], *Susan Sahm* [1], *Shan Sun* [2], *Jian-Wen Bao* [1], *Tom Henderson* [3], *James Rosinski* [1], *Tanya Smirnova* [1], *Brian Jamison* [1]

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A Flow-following finite-volume Icosahedral Model (FIM) has been developed for global short- to medium-range weather forecasting. The model combines four distinctive features, including a quasi-uniform icosahedral horizontal grid, an Arbitrary Lagrangian-Eulerian (ALE) vertical coordinate, conservative finite-volume operators, and an efficient indirect addressing algorithm. Parameterization of physical processes makes use of the current operational version of the physics used in the USA National Weather Service Global Forecast System (GFS).

We have been running FIM, initialized with the same state as the operational GFS, in both real time and retrospective modes at the Earth System Research Lab of NOAA, and find that by both the standard anomaly correlation metrics and other objective measures of forecast skill it is comparable to the GFS, though with not identical characteristic errors when viewed from a synoptic perspective, indicating it should contribute to ensemble diversity. The FIM has also been run in an ensemble configuration for tropical cyclone prediction. In our presentation we will discuss the chief features of FIM, and show objective verification results as well as examples of FIM forecasts and of FIM / GFS forecast differences.

1C2.3 ID:5695 14:30

Computer-Generated Guidance for Forecasting the Potential for Blizzard Conditions

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The occurrence of blizzard conditions constitutes a high impact weather event in the Arctic and southern Prairie Provinces due to the hazardous combination of cold temperature, high wind speed, and low visibility in snow and/or blowing snow. Blizzard conditions can last anywhere from a few hours to several days in localities north of the Arctic tree line. Important factors for the development of blizzard conditions are low temperature, high wind speed, snow availability, snowpack condition, and terrain openness. About half of Arctic blizzard events occur with a “clear sky”, that is, they are due to blowing snow alone. A secondary condition for blowing snow is the low level lapse rate since the less stable the air is, the easier it is to lift snow into the air. Given the vast domain that Canadian operational forecasters are responsible for, there is a need for computer-generated medium time-range guidance to direct attention to those areas where blizzard conditions may develop. Blizzard conditions are due to a combination of several weather elements. Forecasts are not directly output by NWP models. Two types of area forecasts derived from CMC RDPS model output fields are produced by the Hydrometeorology and Arctic Lab. These are: (1) a 6-category classification of the potential for blizzard and near-blizzard conditions, and (2) the probability of visibility ≤ 1 km in blowing snow and concurrent snow and blowing snow. Hourly 1-48 hr forecasts covering all of Canada are currently produced in real-time twice daily. Extension to a 5 day forecast period is planned. Both forecasts are widely used by forecasters in the Prairie and Arctic Storm Prediction Centers in Edmonton and Winnipeg and the Canadian Meteorological Aviation Centre in Edmonton to provide guidance for issuing blizzard watches and warnings. The forecast algorithms, some case studies, and verification results will be presented.

1C2.4 ID:5563 14:45

An update on scatterometer data exploitation at the National Hurricane Center

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The decade of QuikSCAT ocean surface wind vector acquisitions, with almost global and twice daily coverage, was a boon for operational forecasters. Although that era ended in November 2009, its legacy is a better understanding and treatment of today's European Advanced Scatterometer (ASCAT) and Indian Oceansat-2 Scatterometer (OSCAT). It may be fair to say that our use of raw Normalized Radar Cross Section (NRCS, or backscatter) remains somewhat rudimentary however, under most high wind conditions of interest. QuikSCAT, ASCAT, and OSCAT acquisitions are thus continuing to facilitate advances in the treatment of scatterometer data. We explore the utility of satellites and wind retrieval methods that are already, or may soon be, operational at NHC. Detection of storm-force (48-63kt) gap wind events in the Gulf of Tehuantepec and the assessment of tropical cyclone intensity and 34/50/64-kt wind radii (subject to resolution limitations and the presence of rain) are the main operational challenges examined, both in the context of the most recent year of warning events and earlier. The ASCAT high-wind bias (low) relative to QuikSCAT has been reduced. Although QuikSCAT's coverage near the satellite ground track is desirable, it has only been possible to extend ASCAT's coverage more toward the coast. The potential for OSCAT to deliver both the high resolution and coverage of QuikSCAT is explored, along with a proposed treatment of rain contamination.

1C2.5 ID:5500 15:00

A community post-processing system for improving operational NWP forecasts

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A new statistical post-processing system is presented. The goal of the system is to provide a software framework for collecting various statistical methods for improving NWP forecasts. The aim is to expedite the conversion of research methods to operational usage and allow for easier performance comparisons of various post-processing methods. The system takes as input forecasts from one or more NWP model runs and produces improved deterministic and probabilistic forecasts.

The proposed system is inspired by the same community development paradigm of the weather research and forecasting (WRF) model. Developers of this system can contribute different post-processing schemes

in a number of different categories. Analogous to physically-based components such as radiation, microphysics, and boundary layer schemes found in WRF, this system has instead a number of statistically-based components, each of which aim to improve a particular aspect of the NWP forecasts.

For forecast users, the system can be used to find combinations of different post-processing schemes that work best for their particular forecasting problem. For method developers, the framework provides component abstraction and also provides built in functionality such as parameter estimation algorithms to ease development. The system's features are illustrated by a case study.

1C2.6 ID:5386 15:15

Development of a mesoscale network to support the Pan-American and Para-Pan American Games in Toronto, Ontario - Summer 2015.

Rob Simpson
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The 17th Pan-American and Para-Pan American Games are to take place in Toronto, Ontario, Canada and the surrounding area during the months of July and August of 2015. Over 40 countries from the Americas are expected to participate. The actual size of the 2015 Games will be greater than that of the Vancouver 2010 Olympics although the public profile will not be as high.

In support of its mandate, Environment Canada will be responsible for ensuring the safety and security of the general public, athletes, officials, and volunteers, from severe or significant weather. Weather forecast challenges include convective activity, lightning, wind shifts (for sailing events), Humidex values, and, other significant weather affecting large public gatherings and/or athlete safety.

Throughout the Games, Environment Canada will provide area-wide severe weather watches, warnings and advisories in order to alert the public, as well as general 7-day forecasts for everyday planning activities.

In addition, Environment Canada will construct and operate a new mesoscale network to augment the existing data points currently in the Greater Toronto Area.

This session will give an overview of the mesonet, its development and design, and, progress-to-date, with emphasis on the sensors being used. Environment Canada fulfilled its mandate with the support of the 2010 Winter Olympics, overcoming great geographical challenges to provide a world class monitoring network. The new challenges presented by an urban environment will be discussed in the session.

Coastal Oceanography and Inland Waters PART 1 / Océanographie côtière et eaux intérieures PARTIE 1

Room / Endroit (Symphonie 1), Chair / Président (Guoqi Han, sponsored by / commandité par A-O and T&F), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C5.1 ID:5552 INVITED/INVITÉ 14:00

Examination of the Far-field Effect of Tidal Energy Extraction in the Minas Passage on Circulation and Hydrography in the Bay of Fundy and Gulf of Maine using a Shelf Circulation Model

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A nested-grid shelf circulation model based on the POM was developed for the Gulf of Maine and the Bay of Fundy (GoM-BoF). 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. A two-way nesting technique is used in exchanging information between the parent and child sub-models. The shelf circulation model was successfully in examining the far-field effect of tidal in-stream energy extraction in the Minas Passage of the BoF on the three-dimensional (3D) barotropic tidal circulation in the GoM-BoF (Hasegawa et al., 2011). In this study, the nested-grid model is used in examining the far-field effect of the tidal in-stream energy extraction on the 3D baroclinic circulation and temperature/salinity distributions in the GoM-BoF. The tidal in-stream energy extraction is parameterized in terms of nonlinear Rayleigh friction in the model momentum equation. Two special cases are considered in which harnessing tidal in-stream energy is taken from (a) the entire water column and (b) the lower water column within 20 m above the bottom in the Minas Passage. The model results in these two cases will be presented.

1C5.2 ID:5747 14:30

Hurricane Igor impacts on the stratification and phytoplankton bloom over the Grand Banks

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On September 21-22, 2010, Hurricane Igor caused most severe damage in Newfoundland by a tropical cyclone in the island’s recent history. Nevertheless its impact on the ocean physical and biological environments over the adjacent Grand Banks of Newfoundland has not been investigated. In this study we used satellite observations as well as in situ data to investigate the storm-induced changes of sea surface temperature and chlorophyll concentration. The satellite data indicate a salient decline (6 oC) of the sea surface temperature and a significant increase (0.8 mg/m3) of phytoplankton concentration after the passage of the hurricane. The temperature decrease was supported by the buoy measurements. In situ density profiles show the mixed-layer depth increased from 18 to 60 m. The phytoplankton bloom is thought to be triggered by the entrainment of the mixed-layer deepening due to the strong wind mixing and also by the upwelling associated with the cyclone.

1C5.3 ID:5390 14:45

Subgrid resolution in a regional ocean model.

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Accounting for subgrid variations in geometry is a longstanding problem in surface water hydrodynamics. This problem arises in several ways: In many cases objects in the flow are too small in scale to consider resolving, and in other cases there can be tremendous savings in computer resources by limiting the

resolution. A general approach for estimating subgrid effects is the use of double-averaging techniques. In simple terms, volume averages in space and time are calculated and include terms that arise from the stresses exerted by the subgrid objects. In a related method primarily used to account for subgrid topographic variations, the subgrid data is incorporated directly into the model which mitigates problems associated with forming closures. These methods are illustrated by several examples. One example is the inclusion of form drag from subgrid-scale turbines in a study of tidal power potential. Another example is the inclusion of subgrid geometry in a study of tsunami runup.

1C5.4 ID:6173 15:00

A numerical study of the effects of St. Lawrence River discharge variations over the Gulf of St. Lawrence and the Scotian Shelf

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The effect of freshwater runoff from the St. Lawrence River (SLR) on circulation and hydrography in the Gulf of St. Lawrence (GSL) and over the Scotian Shelf is examined using a nested-grid coastal circulation modeling system based on the Princeton Ocean Model. The system consists of a two-dimensional and barotropic outer model, whose domain spans the eastern Canadian seaboard, and a three-dimensional and baroclinic inner model whose domain includes the GSL, the Scotian Shelf, and the Gulf of Maine. Both models are forced at the surface by winds and atmospheric pressure from the North Atlantic Regional Reanalysis (NARR) dataset. The inner model is additionally forced at its lateral open boundaries by tidal elevation and currents, as well as temperature, salinity, and current fields produced by a circulation model of the North Atlantic Ocean. Surface fluxes of heat and fresh water are calculated interactively from the simulated ocean surface state and atmospheric input from NARR. Three numerical experiments are conducted. In the first experiment, in addition to the forcings described above, the inner model is forced by the climatological annual cycles of freshwater runoff from the SLR and other rivers in the region. In the second and third experiments, the SLR runoff values represent a dry year and a wet year respectively. Based on the results of the three experiments, we discuss the extent to which variations in the SLR discharge can affect the circulation, vertical stratification, and salinity over the western GSL and the eastern Scotian Shelf.

Low-frequency variability and predictability PART 1 / Variabilité et prévisibilité des oscillations de basse fréquence PARTIE 1

Room / Endroit (Symphonie 2), Chair / Président (Youmin Tang), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C6.1 ID:5348 14:00

Do GCM’s predict the climate - or low frequency weather?

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Do GCM's predict the climate…. Or the low frequency weather? S. Lovejoy1, D. Schertzer2, D. Varon1

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Using reanalyses, monthly surface series, "multiproxy" series of the Northern hemisphere, and GRIP and Vostok paleotemperatures we show that there are three qualitatively different regimes of atmospheric variability each characterized by a fluctuation exponent H. Mean fluctuations in state variables (such as temperature) vary as ΔT ≈ Δt**H where Δt is the duration. At weather scales we generally have H>0; fluctuations grow with scale whereas for Δt >τw (≈ 10 days), H changes sign and they decrease; this is the "stable" low frequency weather regime. Finally for longer times, Δt>τc ≈ 10 - 100 years, once again H>0, the variability increases with scale: the true climate regime. This different variability allows us to objectively define the weather and the climate.

We show that the intermediate low frequency weather regime is the result of a "dimensional transition": at temporal scales longer than the typical lifetime of planetary structures (τw), its statistical properties are well reproduced not only by stochastic cascade models of weather, but also by control runs (i.e. without climate forcing) of GCM based climate forecasting systems including those of the Institut Pierre Simon Laplace (Paris) and the Earth Forecasting System (Hamburg).

In order for these systems to go beyond simply predicting low frequency weather i.e. in order for them to predict the climate, they need appropriate climate forcings and/ or new internal mechanisms of variability. Using statistical scaling techniques (especially Haar wavelets) we examine the scale dependence of fluctuations from forced and unforced GCM outputs, including from the ECHO-G and EFS simulations in the Millenium climate reconstruction project and compare this with data, multiproxies and paleo data.

At present it seems that even forced GCM's lack sufficient multicentennial, multimillenial variability, that they continue to model low frequency weather out to long time scales.

1C6.2 ID:5465 14:15

Evaluation of Northern Hemisphere blocking climatology in the Global Environment Multiscale (GEM) model

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The performance of the Global Environmental Multiscale (GEM) model, Canadian operational numerical model, in reproducing atmospheric low-frequency variability is evaluated in the context of Northern Hemisphere blocking climatology. The validation is conducted by applying a comprehensive but relatively simple blocking detection algorithm to a 20-year (1987-2006) integration of the GEM model in climate mode. The comparison to reanalysis reveals that, although the model can reproduce Northern Hemisphere blocking climatology reasonably well, the maximum blocking frequency over the north Atlantic and western Europe is generally underestimated and its peak season is delayed from late winter to spring. This contrasts with the blocking frequency over the north Pacific which is generally overestimated during all seasons.

These misrepresentation of blocking climatology are found to be largely associated with the biases in climatological background flow. Modelled stationary wave shows a seasonal delay in zonal wavenumber 1 and an eastward shift in zonal wavenumber 2 components. High-frequency eddies are however consistently underestimated both in the north Atlantic and Pacific, indicating that the biases in eddy fields might not directly contribute to the blocking biases particularly in the north Pacific although they may play an indirect role.

1C6.3 ID:5587 14:30

The Gaussian Predictability Of Wind Speeds

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The linear predictability of wind speed using Gaussian predictors, relative to the predictability of the vector wind components, is considered. Analytic expressions for the correlation-based wind speed prediction skill are obtained in terms of the prediction skills of the vector wind components and their statistical moments. This analysis is facilitated by the assumption that the vector winds are Gaussian, and by the fact that fluctuations of the wind speed are highly correlated with those of its square. It is shown that:

1. at least one of the vector wind components is generally better predicted than the wind speed

2. wind speed predictions constructed from the predictions of vector wind components are more skillful than direct wind speed predictions

3. the linear predictability of wind speed (relative to that of the vector wind components) increases as vector wind fluctuations become smaller relative to their mean value

These model results are shown to be broadly consistent with linear predictive skills assessed using sea surface wind observations from the SeaWinds scatterometer. Biases in the model predictions are shown to be related to the degree to which vector wind fluctuations are non-Gaussian.

1C6.4 ID:5615 14:45

Observed climatology, seasonal cycle and intraseasonal variability of the tropical Cold-Point Tropopause

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The fine-scale structure of the tropical cold-point tropopause (CPT) is examined using high-resolution temperature profiles derived from COSMIC GPS radio occultation measurements. The climatology, seasonal cycle and intraseasonal variability are analyzed for three CPT properties: temperature (T-CPT), pressure (P-CPT) and sharpness (S-CPT). The climatological P-CPT is largely homogeneous in the deep tropics, whereas T-CPT and S-CPT exhibit local minima and maxima, respectively, at the equator in the vicinity of deep convection regions. All three CPT properties, however, show coherent seasonal cycle in the tropics; the CPT is colder, higher (lower in pressure) and sharper during boreal winter than during boreal summer. This seasonality is consistent with the seasonal cycle of tropical upwelling, which is largely driven by stratospheric and near-tropopause processes, although the amplitude of the seasonal cycle of T-CPT and S-CPT is modulated by tropospheric circulations. On intraseasonal timescales, P-CPT and T-CPT exhibit homogeneous variability in the deep tropics, whereas S-CPT shows pronounced local variability and

seasonality. The wavenumber-frequency spectra reveal that intraseasonal variability of CPT properties is primarily controlled by Kelvin waves, with a non-negligible contribution by Madden- Julian Oscillation convection. The Kelvin waves, which are excited by deep convection but often propagate along the equator freely, explain the homogeneous P-CPT and T-CPT variabilities. On the other hand, the vertically tilted dipole of temperature anomalies, which is associated with convectively coupled equatorial waves, determines the local structure and seasonality of S-CPT variability.

1C6.5 ID:5385 15:00

Subseasonal prediction of wintertime North American surface air temperature using the MJO signal

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A multi-variable linear regression model is constructed based on the status of the Madden-Julian Oscillation (MJO) and persistence in order to forecast wintertime surface air temperature anomalies over North America out to 4 pentads (20 days). The current and previous states of the MJO are utilized as predictors, based on the Real-time Multivariate (RMM) indices of Wheeler and Hendon (2004). Modest skill is found, largely centred over the eastern United States and the Great Lakes. The model skill is seen to be highly dependent on the magnitude and phase of the MJO as well. Beyond the persistence driven 1st pentad, forecasts starting from MJO phases 3,4,7 and 8, that correspond to a dipole diabatic heating anomaly in the tropical Indian Ocean and western Pacific, are more skillful during pentads 2 and 3 than those with other MJO phases at the initial time. The results are compared with the monthly hindcast of the Global Environmental Multiscale Model (GEM). The empirical method proves to be slightly superior to GEM beginning with pentad 3 south of the Great Lakes. This advantage expands and strengthens by pentad 4 throughout much of the eastern United States and into portions of western Canada.

1C6.6 ID:5377 15:15

Simulating the extratropical response to the Madden-Julian Oscillation

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Recent studies have shown that the diabatic heating of the Madden-Julian Oscillation (MJO) has a global impact that may serve as an important signal for subseasonal predictions. To understand the dynamical process of the extratropical response, a primative equation global atmospheric circulation model is forced with an anomalous tropical heating associated with the MJO. Different aspects of the dynamical process involved in the extratropical response are analyzed. In particular, the nonlinearity of the response and the sensitivity to forcing location as well as to the atmospheric condition are discussed.

Clouds, Aerosols and Radiation / Nuages, aérosols et radiation

Room / Endroit (Symphonie 3A), Chair / Président (Jean-Pierre Blanchet), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C7.1 ID:5447 14:00

The treatment of sub-grid-scale clouds and precipitation for two-moment microphysics schemes in NWP models

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Several factors motivate the incorporation of two-moment bulk microphysics schemes into the next-generation numerical weather prediction (NWP) models. Contrary to present operational schemes, where usually only the mass mixing ratios of hydrometeors are prognosed, two-moment schemes also predict the total number concentration of each hydrometeor category. Among other benefits, two-moment schemes improve realism in the calculation of all microphysical processes, provide a better treatment of sedimentation, the representation of size sorting, a more consistent framework for radiative transfer computation, and improve the representation of precipitations and mixed-phase cloud microphysics. However, operational NWP models cover a large range of spatial scales, from a few kilometers to a few tens of kilometers in horizontal resolution. At such a range the cloud field itself can be a sub-grid phenomenon and care must be exercised in choosing a time step for falling precipitation to avoid numerical instability. In this study, we present a simple approach to deal with the sub-grid cloud fraction, precipitation fraction, and large time step for two-moment schemes in large-scale NWP models. This sub-grid scheme has been incorporated within the Milbrandt and Yau (2005) microphysics scheme and tested in the Canadian Global Environmental Multiscale (GEM) NWP model. A series of short term sensitivity experiments using the two-moment scheme, with or without the sub-grid scheme, were performed at regional scale over North America. The results are compared with the operational Sundqvist (1989) cloud scheme, ground measurements of precipitations, and satellite retrieval of condensate amounts using the DARDAR products (Delanoë and Hogan, 2008, 2010).

1C7.2 ID:5531 14:15

Performance and sensitivity tests of the future climate satellite GCOM-C/SGLI's cloud algorithm

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During the pre-launch phase of the future polar orbiting satellite, the Global Change Observation Mission-Climate/Second Generation GLobal Imager (GCOM-C/SGLI), whose objective is the monitoring of the climate - performance and sensitivity tests are conducted on the cloud properties' retrieval algorithm of this satellite. This algorithm uses spectral capacities of the GCOM-C/SGLI satellite and the geometrically corrected radiances of the Advanced Earth Observation Satellite II/Global Imager (ADEOS-II/GLI) to produce the data tested in this study. These data are evaluated against the timely matching cloud products from the Terra/MODerate resolution Image Spectrometer (Terra/MODIS). The main cloud parameters evaluated are: the cloud optical thickness (COT) and the cloud particle effective radius (CLER). The results of this evaluation reveal that the GCOM-C/SGLI algorithm performs relatively well for the averagely overcast scenes examined, with an agreement of the COT and CLER to within 20% of the Terra/MODIS cloud

products. A negative bias is frequently observed with the GCOM-C/SGLI retrieved parameters and, a lower sensitivity to thin and small particles' clouds compared to Terra/MODIS. Possible consequences of these differences on long-term climate variations and the bases of the improvement of the sensitivity of the present algorithm to certain types of clouds are discussed.

1C7.3 ID:5770 14:30

Characterization of Boundary Layer turbulence and Cloud base Statistics using MC3E observations

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The convective boundary layer acts as an interface for transporting fluxes of momentum and scalars (e.g., water vapor, heat, pollutants) from the surface into the free atmosphere. Cumulus clouds forming near the top of the convective boundary layer provide one of the main mechanisms for moistening lower troposphere and preconditioning the deep convection. One of the key issues is to understand what regulates the mass flux of subcloud air into the cloud layer, and its diurnal cycle. The joint NASA/DOE Mid- latitude Continental Convective Cloud Experiment (MC3E) that took place in Oklahoma, during April-June 2011 provided a unique opportunity to study the convective boundary layer and associated clouds using enhanced observations ground- based observations and sounding launches. The field site has ARM (Atmospheric Radiation Measurement) deployments from variety of instrument platforms (e.g., cloud radars, microwave radiometers, sounding network, surface observational network, wind profilers, etc) covering surface, cloud, aerosol and radiation observations. Observations from Doppler lidar, high frequency soundings, profiler data, cloud radar data, along with surface observations provides a comprehensive dataset for better characterization of diurnal evolution of convective boundary layer and to investigate the factors affecting the cloud- base mass flux. The capabilities of cloud radar, wind profiler and doppler lidar in observing the scenes (clouds and convective boundary layer) from different scattering perspective (rayleigh, bragg, and aerosol) is utilized for covering the vertical velocity observations from surface up to the cloud base, in-cloud and cloud-clear interfaces. Profiles of vertical velocity statistics (e.g., mean, variance, skewness, updraft & downdraft fraction, and mass flux) are derived and decomposed for different surface and cloud fraction conditions. Further, the aspects of the existing mass-flux parameters are verified with the observed mass-flux observations and the factors affecting the cloud- base mass flux are investigated.

1C7.4 ID:5631 14:45

Effects of Turbulence on Droplet Growth in Clouds

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In this study, we look at the influence cloud turbulence could have on the growth rate of cloud droplets. Studies so far performed have shown four possible ways by which turbulence enhances cloud droplet growth: 1) increase in relative velocity of the droplets due to the highly intermittent turbulent flow field, 2) increase in terminal fall velocity of the droplets since they generally settle on the downward side of the eddies, 3) increase in collision efficiency between colliding droplets and 4) clustering of droplets in regions of low vorticity. We will look in particular at how these four possible enhancements depend on the intensity of the turbulent flow field. Hereto, a direct numerical simulation will be used that solves the full time-dependent, three-dimensional, incompressible Navier - Stokes equations in a pseudo-spectral method. The

droplet trajectories are solved using a simplified version of the equation of motion for a rigid sphere in a time varying flow. The numerical code used to perform these simulations has been parallelized using MPI. The turbulence is assumed to be homogeneous and isotropic, corresponding to what has been observed in the small-scale cores of adiabatic cumulus clouds. The droplets are tracked for a large number of time steps in order to get accurate collision statistics. Several droplets will be tracked more closely to study in detail the precise interactions of turbulence with the droplet motion. Among others, it will be checked whether droplets mainly collide due to the larger droplet overtaking a smaller droplet, or that a larger number of droplets will collide by moving towards each other.

1C7.5 ID:5655 15:00

Particle size distribution of tropical cirrus clouds determined from ACE-FTS and MAESTRO observations

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Cirrus clouds are a major component of the climate system through their effects on atmospheric radiation. Of all their properties, crystal size distribution is most important for quantification of their radiative effects. The measurements of the Atmospheric Chemistry Experiment (ACE) instruments on board the Canadian SCISAT-1 satellite are ideal for retrieval of cirrus crystal sizes, given that they are obtained in solar occultation and, therefore, are vertically resolved. In previous work size distribution of cirrus was retrieved from IR measurements of the ACE Fourier Transform Spectrometer (FTS). In this work we have combined FTS data with MAESTRO spectrophotometer measurements in the visible. The latter enhance the accuracy of retrievals for smaller crystals, which are most important for the poorly-understood subvisible cirrus. Here, we report vertically-resolved size distributions of cirrus throughout the Tropical atmosphere based on retrievals from hundreds of occultations between February 2004 and February 2011. The gains in retrieving crystal size from both visible and IR spectra, as opposed to IR alone, are also discussed.

General Atmospheric Sciences / Les sciences de l'atmosphère en général

Room / Endroit (Symphonie 4), Chair / Président (Daniel Kirshbaum), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C8.1 ID:5400 14:00

An Eddy Seeding Method for Improved LES Simulations Using Realistic Lateral Boundary Conditions

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The most effective way known to model the structure and effects of turbulence in the convective boundary

layer (CBL) is by applying the Large Eddy Simulation (LES) method. In this method the largest, most energetic eddies are explicitly resolved, while closure assumptions are used to represent the effects of the smallest eddies on the cascade of energy to smaller scales. The accuracy of LES simulations of the CBL in idealized cases with periodic lateral boundary conditions (LBCs) has been well-established. However, when more realistic non-periodic LBCs are used in LES, such as from a mesoscale “parent” model domain with only parameterized turbulent effects, time is required for explicit eddies to ‘spin-up’ and equilibrate. This can lead to unrealistic eddy structures and turbulent behavior near the upwind lateral boundaries of the LES model domain. A new ‘eddy seeding’ method invoking mixed-layer similarity theory is used to demonstrate how more realistic eddy structures can be introduced into the near-boundary region of an LES with realistic, non-periodic LBCs mimicking those derived from a parent mesoscale model without explicit eddies. The eddy seeding method is first demonstrated for a homogeneous case that produces turbulent statistics closely resembling those of a corresponding control simulation with periodic boundary conditions. Applications of the new method to more complex cases are then presented.

1C8.2 ID:5600 14:15

A new one-year global Lagrangian climatology of mass transport in the upper-troposphere and lower-stratosphere

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We present the first year climatology of a new global real-time Lagrangian diagnostic system for stratosphere-troposphere exchange operated daily at Environment Canada. This data set has been producing and archiving daily data since July 20th, 2010. A set of trajectories are calculated every day starting at 00:00 UTC using the operational global forecast at Environment Canada. The trajectories are seeded over the entire globe with even horizontal spacing of 55 km, and a vertical spacing of 5 hPa (between 600 and 10 hPa). We examine i) mass fluxes between the stratosphere and troposphere, i.e. across the dynamical tropopause (2 PVU iso-surface), and ii) mass fluxes across the 380K temperature surface. In the extra-tropics, the transport dynamics across these two surfaces are very different. Mass flux across 380K, the upper surface, is driven by diabatic effects due to the Brewer-Dobson circulation; whereas, transport through the dynamical tropopause is dominated, to a large degree, by quasi-isentropic mixing associated with baroclinic wave activity. The details of the transport between these two surfaces are known to determine the rate of injection of stratospheric ozone into the troposphere. This transport process is still today one of the major cause of uncertainty concerning the tropospheric ozone budget. In this paper, we will present a first one-year climatology of high-resolution global mass transport in the upper-troposphere/lower-stratosphere, including geographical distributions and global mass budgets, and will compare our results with previous studies.

1C8.3 ID:5760 14:30

Improving nonlinear regression forecasting in environmental sciences by combining support vector regression with evolutionary strategy

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The main idea behind machine learning is that computer algorithms are capable of automatically distilling knowledge from data. From this knowledge they can construct nonlinear models capable of making

predictions from novel data in the future. However, environmental modelling problems are typically very noisy. To build a successful predictive model, the correct adjustment of the model parameters is also necessary. For example, in artificial neural network (ANN) models, the number of hidden processing units, the choice of activation functions and the regularization parameter all need to be specified. Similarly, in support vector regression (SVR), typically two or three hyper-parameters have to be tuned. In theory, the establishment of all these parameters requires an optimal search in full state space. Furthermore, in many environmental problems, there is a large number of potential predictors, many of which are irrelevant or redundant. It is possible to make the modelling process less time consuming and sometimes more accurate by removing predictors that are irrelevant or redundant with respect to the task to be learned.

In this work, we developed a hybrid algorithm combining support vector regression with evolutionary strategy (SVR-ES) to give nonlinear predictions for environmental problems. SVR-ES uses uncorrelated mutation with p step sizes to find the optimal SVR hyper-parameters. It runs much faster than the standard SVR with grid search for the hyper-parameters. Three environmental forecast problems used in the WCCI-2006 contest -- surface air temperature, precipitation and sulphur dioxide concentration -- were tested. We used multiple linear regression (MLR) as benchmark and a variety of nonlinear machine learning models including SVR-ES, bootstrap-aggregated ensemble artificial neural network (ANN), SVR with hyper-parameters given by the Cherkassky-Ma estimate, M5 regression tree, random forest (RF) and supervised kernel principal component analysis (SKPCA). We also tested all techniques using stepwise linear regression (SLR) first to screen out irrelevant predictors.

We concluded that SVR-ES is an attractive approach because it tends to outperform the other techniques and can also be implemented in an almost automatic way. The Cherkassky-Ma estimate is a useful approach to minimizing the mean absolute error and also saves computational time related to the hyper-parameter search. The ANN, RF and SKPCA are also good options to outperform MLR. Finally, the use of SLR for predictor selection can dramatically reduce computational time and often help to enhance accuracy.

1C8.4 ID:5316 14:45

On the dynamics of the secondary eyewall genesis in Hurricane Wilma (2005)

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The Weather Research and Forecast model is used to simulate the secondary eyewall genesis (SEG) and evolution in Hurricane Wilma (2005). The structure and time evolution of the secondary eyewall are well captured. The theory of empirical normal modes is then applied to study the SEG. For azimuthal wavenumber 1 anomalies, the wave activity spectra indicate that the leading modes (1 and 2), are vortex Rossby waves (VRWs). The Eliassen-Palm (EP) theorem is used to diagnose the impact of the propagating waves on the formation of the secondary eyewall. Analysis of the EP flux and its time-mean divergence show that in the lower troposphere the VRWs propagate outward outside the primary eyewall. The fact that the critical radius of the leading modes is located close to the region where the secondary eyewall eventually develops suggests that VRWs play an important role in SEG.

1C8.5 ID:5503 15:00

The impact of tropical cyclone activity in the Northern Hemisphere on the Available Potential Energy

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Traditionally, the increase of Available Potential Energy (APE) over synoptic time scales has been thought of as a radiatively driven process, controlled by net radiation deficits and surpluses at low and high latitudes respectively. The inherent implication of this mechanism is that increases in APE generally occur slowly, on the order one to a several weeks. In contrast depletions of APE are most often related to the development of large storms which act to dissipate the mean temperature gradient by displacing cold air to low-latitudes and warm air to high latitudes. The inherent implication of this mechanism is that depletions of APE can happen over relatively short time scales, ranging from a few days to about two weeks. However, an examination of the intraseasonal variation of APE does not really show a mismatch between the preferential time scales of APE increase and depletion. This suggests that synoptic-scale features such as cyclones, including tropical and transitioning cyclones, may also be playing a role in the increase of APE, not only in its depletion.

Consequently an investigation of the impact of tropical cyclones and extratropical transition on the Hemispheric APE since 1979 is performed. Preliminary results suggest that there are two mechanisms by which tropical cyclone activity (including extratropical transition) can act to contribute to rapid increases in APE. These mechanisms include 1) latent heat release at low latitudes associated with non- recurving tropical cyclones and 2) extratropical transition occurring in a strong deformation zone. The former mechanism is associated with the preferential heating of tropical and subtropical latitudes due to large amounts of condensation, while the latter mechanism is associated with in an increase in the temperature gradient by juxtaposing tropical and polar airmasses in a confluent flow regime.

1C8.6 ID:5415 15:15

Characteristics and Origins of Submeso Motions in the Stable Boundary Layer

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Transport and dispersion in the stable boundary layer (SBL) is a complicated atmospheric problem, especially in cases of weak mean wind (< 2 m/s). In these cases, submeso motions, which we define as motions roughly in the range of 2 to 2000 m, of uncertain origin can dominate the shear-generation of turbulence and vertical mixing, as well as generate substantial horizontal dispersion in the SBL. It is thought that at least some of the submeso motions in moderately complex terrain may be associated with mountain waves and/or drainage flows (i.e., meso-gamma activity), although data to confirm this hypothesis have been largely unavailable. To better understand the physical processes involved, we are applying a method involving both observational and modeling techniques. Case studies from nine nights in late August and early September, 2011 with weak mean wind were chosen based on availability of observational data from our network of eight ground-based towers (ranging in height from 2-47 m AGL) and two sodars (with remotely observed wind speed and direction from 30 - ~250 m AGL). Using numerical modeling results from the Weather Research and Forecasting (WRF) model at sub-kilometer (444 m) horizontal resolution in central PA, we classify each of the nine nights as either one which suggests the presence of the aforementioned meso-gamma activity, or one in which this activity was not evident in the simulation. Then for each of the nine nights we examine archived wind and temperature data from the towers and sodars to determine whether meso-gamma activity can be detected. Next, we continue the analysis of the data to determine if submeso motions are present and whether they are related to the meso-gamma activity seen in the WRF simulations. Combining this information with the synoptic conditions and characteristics of the submeso motions themselves, it may be possible to determine the physical origin of the submeso motions in the near-surface SBL. This information would enrich understanding of the SBL and could improve the accuracy of numerical plume dispersion models.

General NWP-WAF PART 1 / NWP WAF en général PARTIE 1

Room / Endroit (Ovation), Chair / Président (R Bruce Telfeyan), Date (29/05/2012), Time / Heure (14:00 - 15:30)

1C3.1 ID:5778 14:00

The utility of upper boundary nesting in NWP

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The importance of stratospheric influences for medium range numerical weather prediction (NWP) of the troposphere has led to increases in the heights of global model domains at operational centers around the world. Grids now routinely extend to 0.1~hPa (approximately 65~km) in these systems, thereby covering the full depth of the stratosphere and the lower portion of the mesosphere. Increasing the vertical extent of higher resolution limited area models (LAMs) nested within the global forecasts is problematic because of the computational cost of additional levels and the possibility of inaccuracy or instability in the high-speed stratospheric jets. An upper boundary nesting (UBN) technique is developed that allows information from high-topped driving grids to influence the evolution of a lower-topped (~10 hPa) LAM integration in a manner analogous to the treatment of lateral boundary conditions.

A stratospheric vortex displacement event in winter 2007 is used to study the effectiveness of the UBN technique. Tropospheric blocking over Europe leads to the development of an amplifying planetary-scale wave in the lower stratosphere that culminates in an anticyclonic wave-break over Asia and a marked increase of wave-1 asymmetry. The rapid evolution of stratospheric potential vorticity (PV) is poorly represented in low-topped models, resulting in PV-induced forecast height errors throughout the depth of the troposphere on timescales as short as 2-5 days. Application of the UBN technique is shown to be an effective way for low-topped configurations to benefit from stratospheric predictability without the problems associated with the inclusion of the stratospheric flow in the higher resolution model domain. The robustness and relative ease of implementation of the UBN technique may make this computationally inexpensive strategy attractive for a wide range of NWP applications.

1C3.2 ID:5499 14:15

A stable treatment of potential temperature for semi-implicit semi-Lagrangian dynamical cores

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Atmospheric motions span a wide array of frequencies, the slowest of which provide us with our day to day

weather. In numerical weather prediction it is necessary to narrow the focus to these lower frequencies for efficiency. The way this is typically done in global modeling is to apply an implicit time-differencing method to terms linked to high frequency motions while applying an explicit method to terms linked to low frequency motions like advection, thereby allowing a larger stable time step. While semi-Lagrangian schemes further increase efficiency by removing the stability restrictions of the standard CFL condition concerning velocity, they are still held to a slightly different deformation CFL condition concerning the local variation in velocity. As such, it is still necessary to slow these fast wave modes in the semi-Lagrangian framework to maintain a stable system.

Semi-Lagrangian systems employing potential temperature as a prognostic variable face a unique dilemma in applying this standard method because the term responsible for gravity wave generation is also a vertical advection term which is absorbed into the total derivative. Application of the scheme in the absence of an explicit gravity wave term results in an unstable system since the fast gravity mode frequencies are not properly reduced. Stability can be maintained at the expense of both accuracy and efficiency by way of artificial damping and reduced time steps.

A new method is developed in which a basic state potential temperature field is defined and advected in an Eulerian fashion while the semi-Lagrangian method is applied to the perturbation potential temperature. As the gravity-wave term in question is now expressed explicitly through the total derivative of the basic state potential temperature, gravity mode stability is returned to the system; the semi-implicit treatment of the new term manages stability with respect to the associated CFL condition. Tests of the new scheme in the Navy Global Environmental Model (NAVGEM) show that the method allows stable integration at typical semi-Lagrangian time steps in the absence of artificial damping.

1C3.3 ID:5807 14:30

Turbulent Hysteresis in a TKE-based Boundary Layer Scheme

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(Presented by *André Plante*)
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In numerical models the planetary boundary layer (PBL) scheme is responsible for simulating the effects of unresolved turbulence on the evolution of the profiles of wind, temperature and moisture. In the Canadian Global Environmental Multiscale (GEM) model, it does so by enhancing vertical diffusion between layers in which turbulence is expected based on the presence of appreciable values of turbulent kinetic energy (TKE). However, under conditions of strong lower-level warm advection as in the warm frontal zone of winter continental cyclones, mixing in the PBL scheme is shown to be too active. During these "warm episodes", this mixing leads to the destruction of vertical temperature gradients and the elimination of near-surface cold air below the "warm nose" of a freezing rain profile. Associated surface temperature guidance errors can approach 10oC within 6h and precipitation phase errors can extend over large areas.

In an effort to identify the source of this relatively infrequent but large model error mode, an evaluation of the current PBL sheme in the context of a typical warm episode is presented. The rapid onset of turbulence is shown to be responsible for the homogenization of the temperature profile within the first few hours of integration. In order to limit the growth of TKE in such cases of marginal instability, the effect of turbulent hysteresis is introduced into the PBL sheme. While simplified turbulent theories suggest that a single "critical" Richardson number exists to define the transition from turbulent to laminar regimes, observations of turbulence suggest that turbulent flows tend to remain turbulent well beyond this value and similarly that laminary flows tend to remain laminar despite subcritical Richardson number values. This hysteretic effect leads to asymmetric TKE evolution near the critical Richardson number and is shown to reduce the over-active vertical mixing during the warm episode cases investigated. Results from analysis cycles further suggest that the inclusion of turbulent hysteresis leads to improved forecast scores at both short and medium ranges, further suggesting that this enhancement of the PBL scheme will produce improved guidance in Canadian operational models.

1C3.4 ID:5475 14:45

Construction of conformal overset grids for adaptive global numerical weather prediction free of strong singularities

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The well-known inefficiencies and numerical problems in numerical weather prediction associated with the convergence of meridians and the polar singularies of a latitude-longitude-based grid system have spurred the development of polyhedron-based alternative grids, such the cubed sphere and the (triangular-gridded) icosahedron. Moreover, except at the vertices, the continuous mappings for these configurations can be made perfectly conformal (angle preserving), which substantially simplifies the adaptation of existing grid-based regional models to these global geometries. However, the unavoidable vertex singularities on continuous polyhedral grids still remain too strong to avoid severe numerical difficulties for any model based on spatial finite differencing. “Oversetting” is a remedy that preserves smooth grid continuity across the middle sections of each edge of the original generating polyhedron, but which relinquishes continuity in the vicinity of each vertex in favor of artificially grafted smooth replacements and extensions of the grid there to provide a region of self-overlapping that is free of strong map singularies. Oversetting requires instead a frequent interpolation and merging of the locally duplicated solutions. A purely localized disfigurement of the grid in this way, however carefully smoothed and blended, cannot preserve the desirable property of conformality. In this presentation new techniques are described that do enable a globally consistent and perfectly conformal polyhedral mapping to be constructed with the oversets automatically supplied in the regions where there would otherwise be vertex singularities. The methods are based on the construction of complex analytic functions that involve Riemann surfaces where the inverse mapping (sphere to polygon) is at least two-valued. Moreover, the technique is capable of an immediate and potentially valuable extension to smooth mappings no longer constrained to correspond to convex polyhedra, and which enables the resolution of the generated grid to possess multiple regions of locally enhanced resolution. Such configurations suggest more unifed alternatives to the traditional separation of models for global, regional and various sub-nested tasks of operational models.

1C3.5 ID:5501 15:00

Numerical Simulations with a Three-Dimensional Spectral Element Model

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Highly accurate numerical methods for solving partial differential equations that have been traditionally used in the computational fluid dynamics have yet to be fully exploited for geophysical fluid dynamics applications, such as weather prediction. We will present results obtained with a fully compressible, non-hydrostatic spectral element (SE) model in three dimensions. All of our results are obtained using an eighth order polynomial (p=8), which provides the best compromise between accuracy and computational cost. The number of elements (h), into which the computational domain is decomposed, is varied among

experiments to achieve different effective spatial resolutions. Introducing physical parameterizations into an SE model is challenging due to a number of aspects including the varying nodal spacing within each element. We highlight some of these challenges and our approaches to address them. The model is applied in a series of idealized experiments that include physical process parameterizations such as: i) flow over complex terrain with sub-grid scale mixing, and ii) a sea breeze that includes an evolving planetary boundary layer with surface fluxes. We discuss the issues that arise when physical parameterizations are introduced into SE models. Also, scalability results over many computational cores will be addressed. In addition, we will compare the efficiency and accuracy of the results with a finite difference model (FD).

1C3.6 ID:5679 15:15

An investigation of simulated boundary layer winds in low-level jet cases observed during the Wind Forecast Improvement Project

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The prediction of winds in the lowest 200 m of the atmosphere is crucial for the design, operation, and maintenance of wind farms. The lack of standard observations in this layer makes the development and verification of numerical weather prediction models difficult for wind energy applications. The Wind Forecast Improvement Project (WFIP) is a collaborations between the National Oceanic and Atmospheric Administration (NOAA) and the Department of Energy (DOE) as well as two private sector groups, WindLogics and AWS Truepower. A primary goal of WFIP is to fill the void in observations of the lower atmosphere by deploying a regional network of remote sensing observing systems, along with existing tower and nacelle anemometer data in the upper Midwest and Texas. With this concentrated data source, efforts towards planetary boundary layer (PBL) scheme development can be focused on improving the wind forecasts at heights important for wind energy applications.

Several low-level jet cases have been chosen to investigate important PBL model parameters important for improving low-level winds forecasts. Tests were performed within the framework of a high-frequency data assimilation system, the Rapid Refresh (RR) and a much higher-resolution nest (HRRR). The RR and HRRR forecast model component is the Advanced Research version of the Weather Research and Forecasting model (WRF-ARW) and utilizes the MYJ PBL scheme. This standard configuration will be tested along with other PBL schemes to assess the model skill at forecasting low-level winds. Several important internal model parameters of the PBL schemes, such as PBL height, mixing lengths, and closure constants are tested. Model simulations are compared with wind measurements from profilers, lidar and towers to show the sensitivity to these model parameters and the potential for improved forecasts.

POSTER - Nowcasting / AFFICHE -Prévision immédiate (WAF)

Room / Endroit (Soprano), Chair / Président (Stewart Cober), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D201.1 ID:5663 15:30

Revisiting the retrieval of refractivity by radar: new formula, new processing.

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An accurate knowledge of moisture is very important for quantitative precipitation forecasting. However, high-resolution moisture data is not readily available. In recent years, the scientific community has tried to obtain better moisture information by either ground-based radar or GPS refractivity retrievals. In this study, we revisit the methodology used for radar refractivity retrieval on two separate fronts.

First, current moisture retrieval methods are based on the formulation of refractive index as function of thermodynamic variables (temperature, pressure, and vapor pressure) proposed by Bean and Dutton (1966). We are interested in improving this formula based on the recent advancements in instrumentation. In addition, we explore the error associated with the use of a refractive index formula.

Second, low-level radar refractivity measurements are derived from radar return from ground targets. Therefore, a good knowledge of the ground targets properties, like heights and usability to retrieve refractivity, are necessary to obtain accurate measurements. We are using information from dual-polarization and multiple elevation angles to improve measurement quality.

1D201.2 ID:5436 15:30

Operation of an extrapolation-based lightning forecast system for very short-range forecast over the Korean Peninsula

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A lightning probabilistic forecast system has been developed to predict lightning strikes for very short-range forecast with observation data of lightning strikes and results of numerical prediction models over the Korean Peninsula. This system focuses on producing probabilistic forecasts of ground-cloud lightning strikes up to 2 or 3 hours. Extrapolation method was used as the main concept of this system. The lightning forecast results have been provided through the very short-range digital forecast of KMA in temporary operation since June 2011. Two kinds of methods were synthesized to develop the lightning probabilistic forecast system. The main method is an extrapolation method that uses a lightning-moving vector calculated from the Variational Echo Tracking (VET) technique used in the nowcasting model, McGill Algorithm for Precipitation nowcasting and Lagrangian Extrapolation (MAPLE). The supplementary method is to use a Lightning Potential Index (LPI) calculated from a numerical prediction model for forecasts of more than 2 hours. The LPI was created with meteorological parameters predicted by Korea Local Analysis and Prediction System (KLAPS) which was optimized for very short-range forecasts. Ground-cloud lightning strikes data set observed by KMA was used for lightning analysis and extrapolation. LPI was calculated from forecast results of KLAPS. The mosaic of lightning strike frequency was used to produce the moving vectors of lightning strikes with VET technique. We assumed that the characteristics of the lightning strike frequency were similar to those of the radar rainfall echoes in the moving patterns to calculate the probabilistic results. The LPI introduced by the National Weather Service Forecast Office in Grand Junction, Colorado, was slightly modified to apply in this system. The skill score of the 1-h lightning forecasts over summer season 2011 was 0.3 and that of 2-h lightning forecasts was 0.16.

POSTER - General NWP-WAF / AFFICHE -NWP WAF en général

Room / Endroit (Soprano), Chair / Président (R Bruce Telfeyan), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D202.1 ID:6172 15:30

Operational perspective on the evaluation of the GEM-Regional-10km model in development / Regard opérationnel dans l'évaluation du modèle GEM-Régional-10km en mode développement

Andre Giguere , *Charles Creese* , *Allan Rahill*
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The next operational version of the Canadian GEM model in LAM-Regional configuration will have a horizontal resolution of 10 km and significant adjustments to some physical parameters. A team of operational meteorologists of the "Analysis and Prognosis Section" at the Canadian Meteorological Center in Dorval has worked together with the model developers before a formal parallel run of the model was launched. Some interesting results were achieved during this cooperation.

La prochaine mouture opérationnelle du modèle canadien GEM en configuration LAM-Régional aura une résolution horizontale de 10km et des modifications significatives à des paramètres de la physique. Une équipe de météorologistes opérationnels de la section "Analyses et pronostics" du Centre météorologique canadien à Dorval a travaillé de concert avec les développeurs du modèle avant que le modèle ne soit proposé formellement pour une passe parallèle. Des résultats intéressants ont été accomplis par cette collaboration.

1D202.2 ID:5542 15:30

Verification of thunderstorm occurrence using the National Lightning Detection Network

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Since the summer of 1983, the University at Albany, State University of New York, has organized a daily thunderstorm probability forecast contest. The contest involves predicting the probability that thunder will be heard during a 24-h period at each of ten locations across the continental United States and the forecasts are verified by standard METAR reports. In recent years, however, there have been several instances, particularly during the overnight hours, in which a thunderstorm failed to be reported in the METAR observations despite its occurrence. During such instances, the forecast contest was verified by, (i) contacting the attendant National Weather Service office directly, and/or (ii) examining Weather Surveillance Radar-1988 Doppler and National Lightning Detection Network (NLDN) data.

Given that the NLDN has continuous space and time coverage, average detection efficiency in excess of 95% and mean location errors of less than 500 m for cloud-to-ground (CG) flashes, we examine the utility of using the NLDN to verify thunderstorm occurrence. In particular, a 17-year thunderstorm climatology (1995–2011) from Global Summary of the Day station observations will be compared to an NLDN lightning

climatology at the ten stations currently used in the Albany Thunderstorm Contest and ten additional first-order reporting stations distributed across a wide range of summertime thunderstorm environments. Questions to be addressed include: (i) how close to a station does CG lightning need to strike for a thunderstorm to be reported in a METAR observation, and does this distance vary by station, (ii) are there detectable trends and interannual variability in thunderstorm occurrence for each station, (iii) are there notable correlations or anticorrelations of mean annual thunderstorm days between stations, and (iv) how do mean thunderstorm day soundings and standard thunderstorm forecasting variables vary from station to station.

1D202.3 ID:5513 15:30

An Analysis of CAPE Tendency in Tornado Outbreaks

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Tornadoes are associated with the most severe forms of atmospheric convection. A key factor in determining whether deep convection will develop is the destabilization of the atmospheric environment. A metric of atmospheric destabilization is the Convective Available Potential Energy (CAPE). Although multiple studies (e.g., Rasmussen and Blanchard 1998, Thompson et al. 2003) have analyzed the relationship between CAPE and the development of tornadoes, there is little research on the potential impact that the rate of atmospheric destabilization may have on the severity of convection. A CAPE tendency equation developed by Emanuel (1994) can be used to analyze the relative importance that surface fluxes, radiative cooling, horizontal advection and vertical advection have in destabilizing the atmosphere.

Here we use the National Centers for Environmental Prediction’s (NCEP) Climate Forecast System Reanalysis (CFSR) dataset to evaluate Emanuel’s equation for real-data cases, including the 4-5 May 2007, 5-6 February 2008, and 25-28 April 2011 tornado outbreaks. Individual terms in Emanuel’s CAPE tendency equation are computed and compared to help assess the importance of the process they represent in the destabilization of the atmosphere. The individual terms are also summed to quantify the overall CAPE tendency and the results are mapped and compared to the observed tornado tracks to evaluate the performance and the applicability of the CAPE tendency equation within the CSFR dataset. Additionally, the magnitude of the CAPE tendency is compared to the number of confirmed tornadoes during outbreaks. These results are also utilized to evaluate the effectiveness of the CAPE tendency equation on severe midlatitude convection.

1D202.4 ID:5604 15:30

Studies of dry airstreams in mature extratropical cyclones with and without comma heads.

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Recent work by other investigators has highlighted the different satellite cloud patterns that attend otherwise similar extratropical cyclones (ETCs). Our research group has undertaken a detailed study of several mature ETCs in each of two clear classes: those with complete comma head signatures, and those with “separated” comma heads. Work on the former group is nearing completion. Using isentropic trajectories based upon the hourly initial fields of the Rapid Update Cycle, the origins, displacement, and velocity of air parcels are examined along the axis as well as the periphery of the dry intrusion in each ETC. For the group with complete comma heads, early results show the expected lengthening and narrowing of the dry intrusion with time. Additionally, trajectories along the axis of the dry intrusion reveal that the center of the dry intrusion is prone to greater wind speeds and displacements (up to 1273 km in 12 hours) than along the periphery of the intrusion, early in its life cycle. However, as cyclones age, dry airstream wind speeds along the periphery of the dry intrusion can grow to rival those along the axis, and even slight broadening of the intrusion has been observed in aging cyclones.

1D202.5 ID:5433 15:30

Using the Advance Research Weather Research and Forecasting (WRF-ARW) model to explicitly forecast hail

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Currently, at the U.S. Air Force Weather Agency (AFWA) the possibility of hail is predicted through a parameterization method using wind shear, mid-level relative humidity, and total column cloud ice. Going forward, microphysics schemes with graupel will now be run on nested high resolution (sub- 2 km) domains in AFWA's Weather Research and Forecasting (WRF-ARW) operational model runs. This study seeks to determine if it is possible to deduce existence, size, and location of hail, both at the surface and within the convective system, from this now-available explicit graupel information. Furthermore, additional microphysics schemes have been added to the WRF-ARW model that include hail as an explicit microphysics class, separate from graupel. It is important to decide if hail can be reasonably predicted without processing it as a separate microphysical class because of the additional computation time that such processing would require.

In this study, five different microphysics schemes commonly available within the WRF-ARW (v. 3.3) modeling framework are examined. Case study simulations using each of these schemes are run, and compared to dual-polarized radar observations to determine if placement of hail or graupel by each scheme within the simulated system is realistic. The Thompson and Morrison (with hail option) scheme simulations are particularly successful. The hail or graupel size distribution inherent within each of these schemes, coupled with the simulated particle mixing ratio, is used to explicitly predict maximum hail size produced by a convective system. These predictions are compared to U.S. Storm Prediction Center (SPC) severe hail reports for several convective episodes.

1D202.6 ID:5717 15:30

Simulating winter season persistent cold air pools using the WRF model

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A cold air pool is a topographically confined, stagnant layer of air that is colder than the air above. Cold air pools frequently occur in mountain valleys and basins, especially in winter season. Persistent cold air pools that last for multiple days can trap air in valleys and basins, allowing pollution to build up and reach unhealthy level. Accurate forecasting when a persistent cold air pool will form and how long it will remain in an area has proven to be challenging.

The Weather Research and Forecast (WRF) model is used to simulate two persistent cold pool episodes observed in December 2010 during the PCAPS (Persistent Cold Air Pool Study) field campaign in Salt Lake Valley, Utah. The WRF simulation adequately captured the structure and evolution of these cold air pools. WRF also successfully simulated the processes leading to a partial breakup during one episode and to the final cold pool removal. The simulation also examined the interaction between the lake breeze from the Great Salt Lake and the cold air pools in the Salt Lake Valley. Finally, a series of model runs were performed to examine the influence of model configuration, physical parameterizations, and initial conditions on the simulations of persistent cold air pools.

1D202.7 ID:5696 15:30

The effects of warmer sea surface temperatures on nor'easters in New England

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New England in winter receives much of its snow from Nor'easters. These storms are sustained by many factors as they move along their path. One important parameter is the sea surface temperature (SST) of the Atlantic Ocean, where many of these systems strengthen and gain much of their structure. Kocin and Uccellini (2004)showed that surface fluxes of sensible and latent heat provide a significant amount of energy to a growing Nor'easter. As our climate continues to warm, and SSTs increase, the intensity of Nor'easters will change, affecting the amount and type of precipitation over New England.

The effects of increased SSTs on Nor'easters have not received much attention. Da Silva et al. (2005) used observations and model simulations to investigate the influence of warmer than normal SSTs on a coastal winter storm off the Southeastern U.S., concluding that the warmer ocean surface resulted in more freezing rain, while not changing the inland surface temperatures.

We have used the Weather Research and Forecasting (WRF) model to simulate four different Nor'easters (Mar 2007, Dec 2007, Jan 2008, Dec 2010) using both observed and 1oC warmer SSTs. The total surface heat fluxes increased in all of the storms, and the resulting simulated storms were all more intense. The influence on the amount of snowfall over land varied from storm to storm. In some cases, bands of heavier snowfall moved in response to the warmer SSTs. These differences will be detailed in the presentation and extended abstract.

Da Silva, R. R, G. Bohrer, D. Werth, M. J. Otte, and R. Avissar 2006: Sensitivity of ice storms in the Southeastern United States to Atlantic SST – Insights from a case study of the December 2002 storm. Mon. Wea. Rev., 134, 1454-1464.

Kocin, P. J., and L. W. Uccellini, 2004: Northeast snowstorms (Volume I: Overview). ISBN: 978-1- 878220-64-6, 818 pages, American Meteorological Society.

1D202.8 ID:5512 15:30

Determining atmospheric flow regimes for particular ensemble biases on high fire threat days

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The goal of this study is to explore why ensemble biases are different on high fire threat days than the warm season average by determining how different synoptic flow patterns impact model performance. This presentation will detail how the 2-m temperature and 10-m wind speed biases are different for a large sample of high fire threat days than the entire warm season (April to September), and then explore changes in model bias as a result of the atmospheric flow regime.

The atmospheric ensemble for this study combines the 13 member Stony Brook University (SBU, 12-km grid spacing) ensemble and the 21-member Short Range Ensemble Forecast (SREF, 32 – 45 km grid spacing) run at the National Centers for Environmental Prediction (NCEP) over the Northeast United States. The Wildland Fire Assessment System (WFAS) Fire Potential Index (FPI) is used to isolate high fire threat days between 2007 and 2009. Since composites can not find potential atmospheric regimes, Empirical Orthogonal Function (EOF) analysis is performed on the NARR data for all high fire threat days and related back to ensemble model bias. This is accomplished by exploring the time-series relationship between each EOF's principal component and each member's model bias. Since each ensemble member is treated separately, the relationship between regime and model bias can be related to each member's model physics. High fire threat days have a cooler and more negative wind speed bias than the warm season average. High fire threat days are commonly associated with an anomalous ridge at 500-hPa over the Great Lakes and Northeast United States, with an upstream and downstream anomalous trough in the Rockies and Atlantic, respectively. EOF analysis reveals two spatial patterns associated with a positive 500-hPa geopotential height anomaly over the Northeast U.S. that is negatively correlated to ensemble temperature bias.

1D202.9 ID:5457 15:30

Numerical weather forecasting tool to predict winds for high-rise construction projects

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Numerical weather forecast products over western Canada are provided by Environment Canada and the National Center for Environment Prediction (NCEP) and while the spatial and temporal resolution of these numerical weather forecast products are sufficient for public consumption there are limitations to the application of these products for predicting winds at multiple working heights for high-rise construction projects. This paper summarizes the implementation of an ensemble approach using the Rapid Update Cycle (RUC), North American Mesoscale (NAM), and the Weather Research and Forecast (WRF) numerical weather models to predict winds at multiple working heights for high-rise construction projects. Technical, scientific and operational characteristics of the system and the results of preliminary model verification studies will be presented.

POSTER - Advances in verification of forecsats / AFFICHE - Avancées en vérification des prévisions

Room / Endroit (Soprano), Chair / Président (Bertrand A. Denis), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D203.1 ID:5683 15:30

Verification Working Group Initiative at CMC (part 2)

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A project has recently been launched to consolidate NWP verification efforts at the Canadian Meteorological Centre.

For NWP producing Centres, verification is a critical component to the development, monitoring and performance tracking of NWP systems. While most systems at CMC have a corresponding verification package, the overall verification effort is spread out and somewhat inefficient and not all packages are operationally supported. It has become increasingly evident that tools and mechanisms need to be consolidated so that the development, transfer to operations and maintenance of verification packages can be better coordinated. The ultimate goal is to have a consistent set of tools suitable for use by the R&D and Operational components across CMC and to have an operationally supported verification package for each operational NWP system.

This presentation will give an overview of the CMC verification strategy to develop and maintain tools to support the R&D verification needs as well as the verification for operational products.

1D203.2 ID:5290 15:30

Recent Enhancements to the Model Evaluation Tools

Tressa Fowler [1], *John Halley Gotway* [2], *Randy Bullock* [2], *Paul Oldenburg* [2], *Tara Jensen* [2], *Bonny Strong* [2], *Barbara Brown* [2], *Anne Holmes* [2]
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Model Evaluation Tools (MET) is a freely-available software package for forecast verification. It is distributed through the Developmental Testbed Center (DTC) for testing and evaluation of the Weather Research and Forecasting (WRF) model. Development has been led by the community: including WRF users, the DTC, and verification experts through workshops and user meetings. MET allows users to verify forecasts via traditional, neighborhood, and object-based methods. To account for the uncertainty associated with these measures, methods for estimating confidence intervals for the verification statistics are an integral part of MET.

Many features of the software were presented at the last workshop. However, the latest release includes many new features. Examples of the existing and new verification capabilities will be shown.

POSTER - Operational Weather Prediction (WAF) /

AFFICHE -Prévision météorologique opérationnelle (WAF)

Room / Endroit (Soprano), Chair / Président (John R. Gyakum), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D204.1 ID:5405 15:30

Data Mining to Forecast Marine Fog

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Using a data mining approach to scour 20 years of observational ship data in Maritime waters, a decision tree is created to predict reduced visibility in fog or mist. Data are randomly split to use 70% for training and 30% for testing. "RapidMiner" freeware, based on the C4.5 decision tree algorithm, generates a decision tree then prunes it to minimize errors and to maximize differences between categories. Expected accuracy is calculated from the test data set. GEM regional, global and ensemble data are accessed for past cases and in real time for Maritime waters. Parameters are assessed at each grid point based on this decision tree to predict fog, mist or clear conditions. These experimental forecast products are available in real time to serve as guidance for marine forecasters. Verification of this technique is ongoing at coastal sites with daily displays comparing observations with forecast values. Monthly scores are in production. Case studies are being investigated in collaboration with an operational marine forecaster.

1D204.2 ID:5521 15:30

On the use of the ensembles by the Quebec Storm Prediction Center in detecting and tracking surface cyclones

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An algorithm initially developed by Sinclair, M. R., 1997 has been used to verify the ability of different ensemble prediction systems in detecting and tracking low pressure centers for the 2009-2010 winter season (November 2009 to February 2010). Preliminary results using Environment Canada regional and global Ensemble Prediction System (EPS) and the National Centers for Environmental Prediction (NCEP) global EPS will be discussed. Furthermore, this study explores the usefulness of the algorithm by the Quebec Storm Prediction Center (QSPC), especially in the context of well defined winter storms approaching the Saint-Lawrence valley. Two case studies will be presented, in both cases the tracking of the low pressure minima being a crucial factor in predicting the type of precipitation for Ottawa and Montreal metropolitan areas.

POSTER- Communicating uncertainty in weather

forecasting and NWP (WAF) / AFFICHE - Communiquer l'incertitude en prévision météorologique (WAF)

Room / Endroit (Soprano), Chair / Président (Philippe Gachon), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D1.1 ID:5474 15:30

A Preliminary Study of Uncertainty in Atmospheric Transport Modelling

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At the Canadian Meteorological Centre (CMC), operational atmospheric transport and dispersion modelling outputs are produced using a single meteorological model, a single set of parameters to define the source of the pollutant, and a single dispersion model. This deterministic approach results in a single realization of the evolution of the plume. An estimate of the uncertainty of computed atmospheric dispersion could give end users a qualitative idea of the inherent variability of the results, and thus aid in decision making.

There are three sources of uncertainty: (1) errors in the specified parameters of the pollutant source, (2) errors in the meteorological fields - calculated by numerical weather prediction models - that drive the dispersion model, and (3) errors in the transport and dispersion model.

A short-term study was undertaken at CMC to examine the uncertainty of its principal operational dispersion modelling systems used for long-range transport. An ensemble approach was taken, running a number of simulations for the same incident, the nuclear reactor accident at Fukushima, Japan in March 2011. One series of ensembles consisted of running several simulations using the same source parameters, with different meteorological fields, from the CMC Global Ensemble Forecast System. Another ensemble was comprised of varying the source term – i.e. the period of emission - but using the same meteorological fields. The transport and dispersion was modeled using MLDP0 (Modèle Lagrangien de Dispersion de Particules d'ordre 0). Thus, for this study, the contribution of the dispersion model to the error was was not examined.

From this small ensemble of dispersion simulations, Times of Arrival and concentration of the plume at selected Pacific radiological stations were compared with observations. Some of these results will be presented and discussed.

POSTER - Colloquium on Climate Services for vulnerable societies / AFFICHE - Colloque sur les services climatologiques destinés aux sociétés

vulnérables

Room / Endroit (Soprano), Chair / Président (Amadou Bokoye), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D2.1 ID:5724 15:30

Forecasting Summer Season Drought in Western Russia

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. During the summer of 2010, a severe drought impacted Western Russia, including the regions surrounding Moscow and Belgorod (about 700 km to the south of Moscow). This was accompanied by high temperatures. Moscow recorded 100o F for the first time in over 130 years of record keeping. The combination of heat, dry weather, and smoke from forest fires caused increased mortality rates in the Moscow Region during July and August, 2010. The excessive heat and humidity in both regions was the result of strong atmospheric blocking from late June through early August. The NCAR-NCEP re-analyses were then used to examine blocking in the Eastern European and Western Russia sector during the spring and summer seasons from 1970 - 2010. It was found that the drier years in both were correlated with more blocking during the spring and summer seasons. During years with more blocking, the Moscow region was noticeably drier in the summer and Belgorod during the spring seasons. . Blocking during these years were also stronger, but not necessarily of longer durations. In Moscow, these years correlated with transitions from El Niño to La Niña years, but the opposite was true further south in the Belgorod regions

1D2.2 ID:5550 15:30

Stations météorologiques représentatives du milieu urbain

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Le territoire urbain présente des propriétés de surface hétérogènes qui influencent les conditions météorologiques locales, donc la représentativité d’une station météorologique. Un projet pilote a été mené à Québec afin, premièrement, de développer un protocole de mesure et d’analyse permettant de caractériser la variabilité spatiale de la température et de l’humidité de l’air à l’intérieur d’un territoire urbain, et, deuxièmement, de caractériser la représentativité des stations météorologiques permanentes à Québec.

La température et l’humidité de l’air ont été mesurées dans la ville de Québec, de juin à septembre 2011, selon deux méthodes d’échantillonnage complémentaires. L’échantillonnage fixe permet la prise de mesures en continu au moyen de senseurs autonomes installés dans des quartiers présentant des caractéristiques de surface variées. L’échantillonnage mobile consiste à sillonner le territoire lors de périodes spécifiques, à l’aide d’un véhicule muni de sondes et d’un GPS, de façon à caractériser la variabilité spatiale à petite échelle.

L’échantillonnage fixe continu a permis de caractériser le patron journalier des variations de la température et de l’humidité de l’air des différents secteurs à l’étude. Les similitudes et divergences avec les stations météorologiques permanentes en place ont été dégagées, notamment en termes de dépassement de seuils

pour le déclenchement du plan d'urgence en cas de chaleur accablante. La variabilité de la température des mesures mobiles était corrélée aux caractéristiques de surface autour des points de mesure. L'expérience démontre que les quartiers les plus urbanisés, dans lesquels aucune station permanente n'est présente, sont les plus chauds. Grâce au protocole développé dans le cadre de ce projet, il devient possible d'évaluer la variabilité de la température et de l'humidité attendue entre les stations météorologiques actuelles et les quartiers d'intérêt. On peut ainsi moduler l'interprétation des données météorologiques disponibles ou justifier la pertinence d'installer de nouvelles stations permanentes en milieu urbain.

POSTER - General Weather and Climate Services / AFFICHE -Services météorologiques et climatiques en général

Room / Endroit (Soprano), Chair / Président (Jacinthe Lacroix), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D3.1 ID:5673 15:30

Renewal of the intensity-duration-frequency curves for Ontario

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The Department of Civil and Environmental Engineering of the University of Waterloo is collaborating with the Ministry of Transportation of Ontario (MTO) to establish an appropriate method of representing extreme precipitation patterns across Ontario.

The design of highway drainage systems requires local statistics that characterize extreme precipitation. However, these values are only available at limited number of points throughout the province, mostly in southern Ontario. The Waterloo Multiple Physiographic Parameter Regression (WATMAPPR) technique is used to interpolate Meteorological Services of Canada station data. Stations statistics are regressed onto the regional and local physiographic parameters from WATMAPPR database.

A single province-wide set of statistically-significant equations were developed that are the basis for a new set of IDF curves for Ontario. A beta version was released in 2010. This was recently replaced by the operational version, which includes new equations based on Manitoba, Ontario and Quebec data and improved treatment of uncertainty. A beta version of the design support system can be found at the following URL: http://www.mto.gov.on.ca/IDF_Curves/

1D3.2 ID:5726 15:30

Weather Communication in Canada: The Weather Network's Coverage of the 21 August 2011 Goderich Tornado

Gina Ressler , *Dayna Vettese* , *Brad Rousseau* , *Amanda De Monte*

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The Weather Network and MétéoMédia play a crucial role in the communication of weather information. This role becomes extremely important during severe weather events, when the proper dissemination of the forecast, as well as Environment Canada watches and warnings, is vital to public safety. During severe weather events, The Weather Network employs a multi-platform approach (including television, the web, and social media) to ensure the timely and accurate dissemination of information to as many customers as possible.

In this poster, we describe the strategy employed by the Weather Network team during one of the most significant Canadian weather events of 2011 – the tornado that devastated the town of Goderich, Ontario on August 21. A brief meteorological overview of the event is given. We then outline the communication of the severe weather potential in the days and hours leading up to the event, as well as the action taken by our meteorologists, on-camera presenters, producers, and news writers during the storm itself. We also describe our follow-up coverage in the days and weeks after the event, as the community came together to clean up and rebuild.

1D3.3 ID:5530 15:30

An Useful Way to Get a Severe Weather Message

Dorina Surcel-Colan [1], *Martin Bélanger* [2], *Bertin Ossonon* [1]
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Severe weather events are constantly monitored and covered by MétéoMédia and The Weather Network. When significant weather occurs in the region or when the Meteorological Service of Canada issues weather advisories, a special approach is taken at MétéoMédia to insure appropriate dissemination of information to our customers. In this poster we present the strategy applied by the briefing meteorologists of MétéoMédia in the case of severe winter events. Looking at some examples of snowstorms during the winter of 2011-2012, we will describe the actions taken up to three days in advance to provide information for the production television teams, the news writers and the public. We will also summarize the covering offered by MétéoMédia during a severe winter event and how we have provided our customers detailed information about the evolution and the socio-economic impacts of this event.

POSTER - Atmospheric Remote Sensing of the Arctic / AFFICHE -Télédétection atmosphérique de l'Actique

Room / Endroit (Soprano), Chair / Président (John C. McConnell), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D205.1 ID:5677 15:30

Wind Observations with the E-Region Wind Interferometer at Eureka, Nunavut

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The E-Region Wind Interferometer (ERWIN) has been taking wind measurements at Eureka, Nunavut (80N, 86W) during the winters from 2008 to 2011. The new data analysis routine allows for the determination of winds in five directions (north, east, south, west, and zenith) for three airglow emissions (green line, OH, and O2) with an observation cadence of ~2 minutes, and an accuracy of ~2 m/s. These wind observations provide insight into the various waves and tides present above Eureka. Given the high time resolution of the wind measurements, not only can longer period oscillations such as tides be observed, but also smaller period phenomena can be observed. This presentation will summarize the last three years of observations.

1D205.2 ID:5317 15:30

Trace Gas Retrievals Using The Polar Atmospheric Emitted Radiance Interferometer (P-AERI)

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The Arctic is expected to experience the most drastic change in its environment due to Climate Change. The main increase in the global temperature is attributed to carbon dioxide; however, some research has shown that the combined effect of traces gases will be equal to that of CO2 (Ramanathan, 1985). It is therefore important to have a well-developed data record of trace gas column amounts to observe patterns of change. The overall objective of this research project is to retrieve the amounts of trace gases over a three-year period (March 2006 – April 2009) where the Polar Atmospheric Emitted Radiance Interferometer (P-AERI) was at the 0PAL facility at Eureka, Nunavut. The P-AERI has a spectral coverage from 500-3000cm-1. The retrievals focused on the trace gases; CO2, CH4, H2O, O3, N2O, HNO3, and CO. The findings of this project may allow for a better understanding of seasonal patterns in trace gas column amounts over the time period. In addition, measurements are compared to those from the Extend Range Atmospheric Emitted Radiance Interferometer (E-AERI) that was located nearby, but at a higher elevation (600m), from October 2008 to April 2009.

POSTER - Science Support of Air Quality Management / AFFICHE -La science au service de la gestion de la qualité de l'air

Room / Endroit (Soprano), Chair / Président (Robert Nissen), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D206.1 ID:5553 15:30

Le Programme de surveillance de la qualité de l'air au Québec

Roger Lemire
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Le Programme de surveillance de la qualité de l'air a pour objectif la mesure de la concentration de certains polluants et le suivi de son évolution à long terme. Il cible tant les zones urbanisées densément peuplées que les milieux ruraux exposés à des émissions ponctuelles ou industrielles. Il est constitué d'un réseau de 76 stations dont 59 sont exploitées par le ministère du Développement durable, de l'Environnement et des Parcs. Les autres stations sont opérées par la Ville de Montréal, Environnement Canada, ou en collaboration avec des industries ou des associations industrielles. Les stations sont réparties dans 57 municipalités, 41 MRC et 15 régions administratives. Certaines stations supplémentaires sont mises en fonction pour répondre aux besoins de projets spéciaux (exemple : prolongement de l'autoroute 25 à Montréal).

La prise de mesure de certains polluants (SO_2, H_2S, CO, NO_X, O_3) et des particules fines ($PF_{2,5}$) se fait en continu, tandis que la concentration des particules en suspension totales ainsi que d'autres substances toxiques sont mesurées à intervalle régulier.

Depuis 2009, le Service de l'information sur le milieu atmosphérique procède à la modernisation du réseau de mesure. L'installation d'un nouveau système de collecte des données rend désormais possible l'évaluation à distance de l'état de fonctionnement de l'instrumentation. L'acquisition de nouveaux outils de validation plus performants assure une amélioration de la qualité des données archivées. Une salle de certification permet l'étalonnage des appareils avant leur installation sur le terrain.

Les mesures prises en continu servent à la diffusion en temps quasi réel d'un indice de qualité de l'air et sont aussi utilisées dans le cadre du Programme de prévision de la qualité de l'air (Info-Smog). Enfin, toutes les données de la qualité de l'air sont rendues disponibles aux citoyens, chercheurs et autres personnes intéressées par l'entremise du service Info-Air (infoair@mddep.gouv.qc.ca).

1D206.2 ID:5478 15:30

Exploratory application of the inverse dispersion method to estimate fugitive methane emission from a landfill.

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Line-averaging laser methane detectors were operated in proximity to known or suspected sources of landfill gas, and the inverse dispersion method, based on a Lagrangian stochastic trajectory model, was used to provide an estimate of the methane emission rate. Ambiguity in assigning boundaries to the emitting regions, the necessity to aggregate different types of sources (strong localized vents versus broad areas of slow seepage) and irregularity of the topography and vegetation imply that the results be interpreted in the spirit of an order-of-magnitude estimate.

1D206.3 ID:5596 15:30

The Detection of Weekday-Weekend Effect of Extreme Ground-level Ozone (O3) Events in Toronto Downtown area, Canada

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Ground-level ozone (O3) is perhaps the most familiar pollutant because it is associated with smog alerts. The 2000 to 2008 weekday-weekend variations of ozone concentration in the Toronto Downtown area of Canada were examined. The goal of this work is to determine whether the weekday-weekend effect of extreme ozone events could be detectable during the nine-year study period. The results from this research show that during the study period, there were a total of 85 days (about 2.59% out of the whole study period) listed as the 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 Toronto Downtown site. A Days-of-the-Week ratio of 0.46 is generated with the 26 weekend days and 59 weekdays having the extreme ground-level ozone events. This ratio is higher than the ideal normal of 2:5 or 0.4 (two weekend days and five weekdays in a typical seven-day week). In addition, the hourly O3 concentration curves generated in this research show that the hourly average weekend O3 concentrations were higher than the hourly average weekday O3 concentrations, especially during the hours between 6:00hr to 9:30hr (24-hrs). As a result, the weekday-weekend effect of extreme ground-level ozone events was detectable in the Toronto Downtown area of Canada during the period from 2000 to 2008.

1D206.4 ID:5413 15:30

Ground Level Ozone Chemistry and the Weekday/Weekend Effect in Ontario

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Despite successful efforts to reduce ground level ozone precursors over the past decade in the Greater Toronto Area (GTA) there has been no decrease in ground level ozone concentrations. Part of this may be the result of transboundary pollution, however it is also likely a result of the ozone chemistry of the region. While nitrogen oxides (NOx) are a precursor to ground level ozone, at high concentrations relative to volatile organic compounds (VOCs) they lead to ozone scavenging. Day of the week variations of ground level ozone concentrations have been observed in cities around the world and have been attributed to variations in NOx concentrations on weekdays compared to weekends. However, very little research has been performed to test this hypothesis. This study examined ozone and NOx data from 39 monitoring stations across Ontario. Periods of depressed ozone concentrations were correlated with elevated NOx concentrations providing evidence for ozone scavenging by NOx. This suggests that most of Ontatio is in a NOx saturated area of ozone production, and in order to reduce ozone concentrations VOCs would have to be reduced relative to NOx. This may prove to be challenging as VOCs are a more diverse group of compounds released from many sources both anthropogenic and natural. In addition a positive correlation was found between the population of an urban centre and magnitude of the weekend effect. This study provides a basis for further research into ground level ozone from local to international scales.

POSTER - Clouds, Aerosols and Radiation / AFFICHE -Nuages, aérosols et radiation

Room / Endroit (Soprano), Chair / Président (Jean-Pierre Blanchet), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D4.1 ID:5543 15:30

Volatile organic compounds and micro-organisms in snow and frost flowers during OASIS 2009 in Barrow, AK

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Volatile organic species (VOC) concentrations and cultivable bacteria and fungi were determined in different types of snow pack and frost flowers. Samples were collected during the IPY Ocean-Atmosphere-Sea Ice-Snowpack program (OASIS) campaign in Barrow, AK and results strive to provide insight into potential exchange and metabolisation processes between and within the snow pack and the atmosphere.

VOC were quantified after melting the sample employing solid phase microextraction and gas chromatography with mass spectrometric detection (SPME-GC-MS). Toluene and m-/p-xylene concentrations were found to be 0.29 ± 0.08 µg/L and acetophenone at levels of 1.3 ± 0.12 µg/L in the first 3 cm of the snow pack. Bromoform ($CHBr_3$) was only found in frost flowers over Arctic sea ice at concentrations of 0.19 ± 0.04 µg/L and most probably of biogenic origin. Additional qualitative VOC data will also be presented.

Cultivable bacteria were observed in frost flowers and snow at 325 and 314 CFU mL^{-1}, respectively). Fungal colonies were found to be present at up to 5 CFU mL^{-1}. A bacterial species isolated from fresh snow was identified as a *Bacillus* species. Other isolates identified were *Afipia genosp*, *Paenibacillus*, *Microbacterium*, and *Kocuria*.

A synopsis of to-date published data originating from the same sampling sites will be presented with the data from this study to provide potential pathways for the destruction and formation of new atmospherically active products.

1D4.2 ID:5832 15:30

Comparison of the near-surface extinction coefficient, PM2.5 and the AOD within the PBL using backscatter LiDAR profiles and multi-spectral sunphotometry

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Analyses of the correlation of near-surface aerosol extinction coefficient <κa(0)>, surface measurements of fine-mode particulate matter (PM2.5) and the fine mode (sub-micron) aerosol optical depth (AOD) within the PBL (Planetary Boundary Layer) enables a better understanding of the relation between columnar and surface aerosol parameters (an important link, for example, between satellite derived AOD and key aerosol surface measurements such as PM2.5). Backscatter lidar profiles from the CORAL Net lidar network were used to extract near-surface <κa(0)> and the height of the PBL while AODs from the AEROCAN / AERONET network were processed to deconvolve the AOD spectra into estimates of fine and coarse mode

AOD. PM2.5 data was obtained from co-located Tapered element oscillating microbalance (TEOM). The measurements were acquired during the summer of 2009 at two sites in southern Canada (Egbert, Ontario and Sherbrooke, Québec). Preliminary results and conclusions will be presented in this communication.

1D4.3 ID:5806 15:30

Applied the updated RRTM radiation of NCEP GFS to regional NEMS

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NOAA Environmental Modeling System (NEMS) is a shared, portable, high performance software superstructure and infrastructure for prediction models at National Centers for Environmental Prediction (NCEP). In additional to the operational GFS and GEFS, a regional NEMS has also been tested under the new infrastructure. The default radiation package in the operational regional model, NAM, was originally developed by GFDL in 1980's with a bulk cloud optical property to its input. Attempt had been made to use RRTM radiations in past years as an alternate while kept the same bulk cloud property as its input. In the recent development, the operational GFS's radiation package including updated RRTM radiations and supporting physics are adapted into the regional NEMS. It allows the radiation physics to be unified in NEMS for global and regional.

To evaluate the impacts of this unified RRTM radiation on the regional NEMS, numerous radiation setups were experimented to compare against the operational NAM results. A prognostics cloud scheme with modern spectral varying optical property for radiation was used to compare with results from bulk cloud property scheme in various radiation settings (the newer vs. older versions of RRTM, as well as the GFDL radiation from the operational NAM). Preliminary results (without further changing and tuning of the model physics) show: 1) the new unified RRTM radiation package with prognostic cloud produces a better vertical temperature FVS performance than the others; 2) but also yields a cold bias in surface 2m temperature. More detailed results from this study will be presented to show the impacts of the unified RRTM radiation on the regional NEMS forecasts.

1D4.4 ID:5569 15:30

Adiabaticity in stratocumulus clouds

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The value of cloud adiabaticity is a measure of the degree of entrainment in the absence of drizzle. Cloud-top entrainment and drizzle can affect the value of adiabaticity. In return, subadiabatic conditions greatly influence the microphysical properties of clouds, and subsequently its radiative impacts. The U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Mobile Facility (AMF) operated at Graciosa Island (Azores) as part of a 20-month long field campaign to study marine boundary layer clouds. The AMF instrumentation and location provides a unique opportunity to observe the cloud properties of marine stratocumulus clouds utilizing a variety of active and passive remote sensors. On the other hand, the suite of instruments located at the ARM Southern Great Plains (SGP) site has been sampling clouds for years, providing a continental data set of stratocumulus clouds. The adiabatic liquid water path (LWP) of the observed stratus clouds is estimated using 6-hourly radiosonde measurements, with the cloud boundaries obtained from a ceilometer (base) and a cloud radar (top). A microwave radiometer provides the observed LWP, allowing the estimation of the cloud's averaged adiabaticity. A technique is also developed to retrieve

the profile of adiabaticity in the absence of drizzle, to help characterize the cloud-top entrainment. Parameters of the droplets size distributions are retrieved at the same time. Results will be presented and analyzed in association with turbulence and cloud entrainment/mixing toward a better understanding of the drizzle initiation requirements.

POSTER - General Atmospheric Sciences / AFFICHE -Les sciences de l'atmosphère en général

Room / Endroit (Soprano), Chair / Président (Peter Bartello), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D5.1 ID:5690 15:30

Large-scale Precursors to Major Lake-Effect Snowstorms Lee of Lake Erie

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Although Lake Effect snowstorms have most commonly been researched at the meso- and synoptic scales, this study focuses on the Northern Hemisphere large-scale pattern observed in the days prior to major lake effect snow events. The initial case list for the study was obtained from the National Weather Service at Buffalo’s online lake-effect snow database. This page records and names major lake-effect events occurring in their County Warning Area from 1998 to the present. The original list was then narrowed down to cases that lasted at least 24 hours, produced at least 12 inches of snow, and had no synoptic-scale forcing. Because we are interested in large- scale patterns that lead to the onset of major lake-effect events, any case that occurred within seven days of a previous case was discounted. As a result we were left with 31 cases from 1998 to 2010. To ensure statistical significance of our results, more cases will be added for a future study. The 31 cases were then stratified into different categories including events that: occurred from January through April; occurred from October through December; lasted for 24-42 hours; lasted for more than 42 hours; were considered shore-parallel; and were considered wind-parallel. These categories were established in order to identify specific large-scale patterns leading up to different types of lake-effect events. Climate Forecast System Reanalysis data was used to composite each category of lake-effect events from event onset to 14 days prior to onset. Due to the relatively small number of lake-effect cases in our study, spaghetti plots were constructed in order to ensure that notable features in the composite were not dominated by one or two cases. Standardized anomalies were also computed using NCEP/NCAR reanalysis data; results from these composite analyses are shown. The state of the Arctic Oscillation, the Pacific North American Pattern, and the Madden Julien Oscillation were also analyzed for the days leading up to and during the major lake-effect events.

1D5.2 ID:5565 15:30

Measurements of GHGs in the US with a Dense Observing Network

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(Presented by *Jim Anderson*)

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Reducing Uncertainty with Carbon Monitoring Systems We have good measurements of the annual global change of CO2 and CH4 in the atmosphere, but there is still considerable uncertainty about the distribution of sources and sinks around the Earth. One way to reduce this uncertainty is to continuously measure CO2 and CH4 at more locations, and combine those measurements with known winds to constrain the possible distribution of atmospheric carbon sources and sinks. Earth Networks is deploying worldwide about 100 cavity ring-down spectrometers, installed on towers, to make continuous measurements of this sort, which we will combine with wind fields to infer maps of sources and sinks. Each GHG instrument also has a calibration unit with consistent quality control performed on the collected data. Sampling is performed at multiple heights. GHG sensors are collocated with professional grade automated weather stations which report data in real time to the Earth Networks GHG network. All collected data is displayed at the web site in real time, which allows monitoring of local conditions. The accuracy of data makes it a reliable source to be used for reporting and verification.

1D5.3 ID:5728 15:30

Characterizing Stratosphere-Troposphere Exchange with Osiris Ozone Observations

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The volume mixing ratio of ozone lies between 1-10 ppmv throughout the lower and middle stratosphere, but is at least an order of magnitude lower in the troposphere. This separation of scales makes it possible to identify intrusions of, for instance, stratospheric air in the troposphere: a tropospheric air parcel with a high ozone mixing ratio likely originated in the stratosphere. Using nine years of Osiris ozone measurements, we plot as histograms the distribution of ozone volume mixing ratios at specific points in potential vorticity - potential temperature (pv-theta) space for each season. We show how the shape of these histograms become a useful tool for identifying regions and seasons of active stratosphere-troposphere exchange.

1D5.4 ID:5634 15:30

A First Look at the Diurnal and Annual Cycle of Precipitable Water Over the Continental United States using Ground-Based GPS Measurements

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The diurnal and annual cycle of precipitable water over the continental United States is examined using the spatial maps of column integrated mixing ratio. The spatial maps of mixing ratio are generated utilizing the Suomi network ground-based GPS receiver measurements over a time span of 3 years (Feb- 2009 to Jan-2012). The wet delay measured from the ground-based GPS receivers are converted into precipitable water vapor (PWV) and in turn into mixing ratio. Topography alters the depth of the column of integration that is eliminated through considering the column integrated mixing ratio instead of PWV. An ordinary kriging interpolation technique is used to generate the spatial maps of mixing ratio. The spatial maps of precipitable water are also helpful in answering the fundamentals questions like where high humidity persists in precipitation, maybe ahead of precipitation, in warm sectors? A distinct diurnal cycle is observed in precipitable water spatially and temporally. During warm season precipitable water is showing a peak in the evening hours over Florida where as in central US (Wyoming) the peak is observed in the midnight hours.

The detailed information on diurnal and annual cycle of precipitable water vapor with animation will be presented during the conference.

1D5.5 ID:5656 15:30

A Statistical Comparison of Weather Stations in Carberry, Manitoba

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There are three weather stations co-located at a site near Carberry, Manitoba operated by Environment Canada, Manitoba Agriculture Food and Rural Initiative (MAFRI) and WeatherFarm (Canadian Wheat Board/Earth Networks). This situation provides the opportunity to compare weather data and results across the different types of stations used in the three different networks. Multiple comparisons between the weather stations measuring different weather variables will be presented.

Study results based on actual sensor data comparisons in Carberry for hundreds of hourly observations for the month of February and May, 2011 and July, 2010 clearly illustrate that there is little statistical difference in the measured variables between the Environment Canada station (control) versus the WeatherFarm station (measured) for temperature, dew point, precipitation and, in most cases, relative humidity, as well as wind speed (February 2011). Additionally, precipitation measurements were also compared between all three stations – WeatherFarm, MAFRI and Environment Canada – and were found to be significantly correlated in all cases. Precipitation measurements for the liquid (rainy) season were also compared between the three station rain gauges, and little statistical difference was found in tipping buckets in relationship to weighing gauge measurements. Further an extreme rainfall event in Saskatchewan is analyzed providing proof that tipping bucket gauges do not underestimate heavy rainfall events. The WeatherFarm network provided highly localized weather data during the storm to capture convection precipitation. This study demonstrates that real-time weather information from the WeatherFarm station sensors is complementary to the Environment Canada stations data, and provides weather information with the granularity necessary for real-time weather event management and decision making relative to flood prediction, monitoring and forecasting. This data has also been used to increase the timeliness and accuracy of watches and warnings and special weather statements issued by Environment Canada.

POSTER - Coastal Oceanography and Inland Waters / AFFICHE -Océanographie côtière et eaux intérieures

Room / Endroit (Soprano), Chair / Président (Jinyu Sheng), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D6.1 ID:5579 15:30

Layered Mixing on New England Shelf in Summer

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Integrated observations on New England Shelf in the summer of 1997 are analyzed to reveal the vertical and time variations of hydrography, flow and turbulence over four semi-diurnal tidal cycles. Density distribution shows the following layered structure: the sub-surface stratification, mid-depth weak stratification, lower-layer stratification and well-mixed bottom boundary layer (BBL). The sub-surface stratification is result of surface heating and the offshore displacement of lighter shelf water by the eastward wind. Increases in surface heating and internal tidal velocity correspond to the deepening of the sub-surface layer. In the mid-depth layer, the presence of weak stratification and very weak shear lead to gradient Richardson number (Ri) greater than 0.25, resulting in weak turbulent dissipation (10-9~10-8 W kg-1). The high-salinity water in the BBL originates from the onshore intrusion of shelf-slope front driven by the eastward wind. Ri is less than 0.25 in the well-mixed BBL but larger than 0.25 in the stratified layer above the BBL, corresponding with the large and small dissipation rates measured in the two layers. The analysis of observational data confirms that the generation of turbulence in the BBL and above is caused by shear instabilities of tidal currents; and the upward intrusion of turbulence is inhibited by strong stratification. The competing effects of shear and stratification in and above the BBL are reproduced with a one-dimensional model over a sloping topography including second-order turbulence closure.

1D6.2 ID:5654 15:30

Evaluating the Potential of RADARSAT-2 High Resolution Imagery for Icefoot Cartograpy.

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Knowing about icefoot climatology recently emerged as an essential part in decision-making policies to address the problem of coastal erosion in the St. Lawrence River estuary (Quebec, Canada). The icefoot plays two roles in the coastal geomorphology, it prohibit sedimentary transport along shore and it can be an erosion vector as it drifts away with incorporated sediments during melting events. For now, there are no precise estimates of the sediment budget associated with such dynamics. As climate changes may cause a reduction in the period which sees a stable icefoot develop along the shore lines of northern environments or cause multiple breakups, it becomes necessary to refine tools to predict and help governments in the management of the different dimensions of the shore line erosion problematic.

With the advent of a new generation of high resolution polarimetric SAR satellites, the extraction of ice structures as narrow as the strip of sea ice that forms the icefoot becomes potentially feasible. However, the classification of such a linear feature remains a challenge. Results obtained from different polarimetric decomposition, filtering techniques and unsupervised and supervised classification methods were compared. In order to assess the validity and interpret the classification results, ground truth data was harvested during field campaigns conducted on the study sites at more or less one day from the time of acquisition. Those data sets consist of icefoot profiles GPS tracks localizing the upper and lower bounds of the icefoot and imagery obtain from automated cameras.

Considering the limitations of unsupervised classifications, it was found that the Entropy, Anisotropy and Alpha-angle parameters classified by the Pottier & Lee method based on the Wishart statistical classifier has great potential to contribute to a better understanding of coastal ice processes and to the decision making process concerning northern coastal regions.

1D6.3 ID:5453 15:30

One and a Half Dimension Circulation Model to issue 48-hours Water Level Forecasts in the St. Lawrence River

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Water level forecasts in the navigational channel are issued using atmospheric forecasts, freshwater run off and tides over the next 48 hours as forcings to a one-dimensional circulation model. The area between Saint-Joseph-de-la-Rive and Montreal is maintained at specific depths by dredging and commercial ship mariners want to use the maximum available water column. Forecasts have to be in the 10 cm range to be of use. We will show that using a one-dimensional model provides good performance. Using an assimilation scheme of the observations every hour improves further the forecasts. Reproducing both tidal amplitude and phase along the whole domain, at 18 control points, proved to be a challenge but the conclusion is that the main source of errors is not the model itself but rather the uncertainties associated with the boundary conditions themselves. From our analysis, the major improvements come from a better way to assimilate the forecasted upstream flow and to use an improved storm surge forecast at the downstream boundary. This conclusion is quite helpful. We will keep this result in mind when we do improve the calculations by using a two-dimensional model.

1D6.4 ID:5490 15:30

Driving the Lake-Lake Bed Exchange with Internal Waves.

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Exchange with the lake bed can have a profound impact on nutrient levels in lakes, especially in oligotrophic (nutrient-limited) lakes. Often a portion of the lake bed is covered with a layer of porous material (e.g. sand) through which water can flow and hence transport nutrients back into the water column. The flow can be driven by density changes (the so-called convective turnover pump) or pressure distributions (e.g. those due to surface waves). For typical boreal lakes, significant portions of the lake are too deep for the influence of surface waves to be felt at the bottom. We discuss pressure distributions induced by internal waves which exist during the temperature stratified summer months in most lakes. These waves are typically much longer than surface waves, and hence induce significant pressure distributions at the lake bed. We find that the geometric distribution of seepage is strongly controlled by both the ratio of porous media thickness to the lake depth and by the distribution of permeability. Finally we argue that in some cases, internal wave-induced turbulence can enhance exchange with the water column by unclogging pores clogged by detritus.

1D6.5 ID:5741 15:30

The Ice Regime of the Koksoak River at Kuujjuaq, Quebec: Formation and Consolidation Processes

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A Shallow Water Ice Profiling Sonar (SWIPS) instrument was deployed in the Koksoak River at Kuujjuaq, Quebec in late September, 2009. The Koksoak River has very large twice-daily tidal ranges of about 4 m.

Located on the river bottom, the SWIPS instrument uses an upward looking sonar to measure the range to the underside of the floating river ice, or the water surface when ice is not present. From the acoustic range and pressure sensor data, the draft of the river ice is determined at typical measurement intervals of 1 or 2 seconds.

The ice regime at the measurement site is strongly influenced by the very dynamic conditions, associated with the large range of tidal heights and currents. Daily ice thicknesses are highly variable due to the tidally driven movement of ice, starting from the initial onset of ice formation (October 15) until the ice consolidates into a stable continuous plate. This continuous plate, established December 13, had an average ice draft of 2.2 m which corresponds to an ice thickness of approximately 2.5 m, which is well above what would be expected from thermal ice growth. These larger ice thickness values are consistent with the occurrence of ice deformation processes (rafting and ridging).

Significant levels of acoustic backscattering are observed episodically throughout the entire water column under the floating ice pans. These episodes of active backscattering throughout the water column occur from the time of first ice formation until the surface ice features become stationary and the water surface is completely ice covered. One interpretation of these episodes of water column backscattering is that they represent the presence of frazil ice. The occurrences of regular episodes of high acoustic backscatter are related to the stage of tide and water and air temperatures.

1D6.6 ID:5704 15:30

Assessing the forcing fields which drive the ocean circulation in the South Coast of Newfoundland

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Understanding and subsequently simulating the circulation in the bays of the South Coast of Newfoundland is becoming critical with the fast growth of aquaculture industry in this area. Various oceanographic and atmospheric instruments were deployed at numerous locations in Forune Bay and Bay D'Espoir to collect vertical profiles as well as time series of temperature, salinity, ocean currents, sea level, and wind speed and direction. The area of interest is a complex estuarine fjord with steep and complex orography which makes local small scale processes important. The presentation discusses the observations and the result of their analysis. A special focus is given to the analyses of the data from a set of current meters deployed to measure the sea level and the current speed in the upper 80 meters of the water column. Tidal analysis using observation data is compared with the output of the unstructured grid finite volume coastal ocean model (FVCOM) run in barotropic mode. Our goal is to gain insight into the fundamental processes governing the ocean circulation in the area and isolate the contribution of the tidal circulation so to assess the role of any other forcing field.

POSTER - Ecosystem-Based Oceanography /

AFFICHE -Océanographie relative aux écosystèmes

Room / Endroit (Soprano), Chair / Président (Laura Bianucci), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D207.1 ID:5711 15:30

Validation of DEPOMOD for estimating desposition from fish farms on the South Coast of Newfoundland

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Environmental regulation of the aquaculture industry in Canada and Newfoundland follows a Pathways of Effect philosophy that consists of Release, Exposure, and Consequence and Acceptability components. One of the pathways for marine finfish cage farms is the release of organic particles (largely fish feed and fish feces) during farm operations. These particulates are transported, dispersed and potentially degraded as they sink toward the bottom. The consequence to the bottom ecosystem depends upon the rate at which the material settles on the bottom and the ability of the ecosystem to assimilate the added flux of organics. In order to assess the surface area of deposition underneath and in the vicinity of fish farms in the South Coast of Newfoundland, currents at different depths were recorded using Acoustic Doppler Current Profiler at locations near aquaculture farms. The current velocity timeseries together with the bathymetry of the area and the feed input data are used to feed the aquaculture waste deposition model DEPOMOD- which is used to model the deposition and biological effects of waste solids from marine cage farms. The result of the analysis of the model output and that of the sensitivity studies for the model is presented. The output is validated using measured carbon deposition at the bottom obtained from the analysis of data from sediment traps installed around the sites. The comparison shows that the model can reproduce the amount of carbon that is measured around the sites. The study also shows that hard and deep bottom under fish farms is depositional. This study validates the use of DEPOMOD as a tool for understanding and forecasting the foot-prints of aquaculture activities in relatively deep-water region on the south coast of Newfoundland.

POSTER - General Oceanographic Sciences / AFFICHE -L'océanographie en général

Room / Endroit (Soprano), Chair / Président (Laura Bianucci), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D7.1 ID:5782 15:30

A round-trip tour of Canada’s Three Oceans (C3O): a Canadian contribution to the International Polar Year

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Changes within the ice-cover, water column and ecosystems of Arctic Canada are inextricably linked to the global system in general and to the bordering subarctic Pacific and Atlantic in particular. It is within this high-latitude domain that the consequences of global change and climate variability are expected to be biggest and fastest. Both observational and modelling results suggest that the major impact of climate change on the marine system will be the re-distribution of oceanic boundaries and habitats/biomes; and this dictates the need to carry out times series observations over broad spatial domains. The oceans surrounding Canada are both geographically and dynamically interconnected. C3O was a multidisciplinary IPY project which aimed to produce a comprehensive view of the physical, chemical and biological oceanic structure of subarctic and arctic waters around Canada and to use this information to establish a sound scientific basis for a long-term Arctic Ocean monitoring program. C3O had two foci: “long-lines” along which hydrographic and biogeographical data were collected on sections crossing the subarctic Pacific, Arctic and subarctic Atlantic and “regional studies” that investigated specific ecodomains. Here we present data collected from 2007-2010, along the C3O circuits of northern North America, and discuss the observed oceanic structures with regards to the global patterns of moisture transport and ocean circulation that force a ‘downhill journey’ of low salinity waters from the North Pacific to the Arctic and then into the North Atlantic.

While C3O began as an IPY effort (2007-2011) its full scientific and social value will be realized only when extended into the future; to 2050 and beyond, as these are the time scales of social relevance as seen by international panels (e.g. Intergovernmental Panel on Climate Chance, Arctic Climate Impact Assessment). It is hoped that the example of C3O will assist in evolving monitoring methods that will in part be turned over to local communities and carried out by northern residents, following a community-based scientific franchise model.

1D7.2 ID:5737 15:30

Excitation of MODE-TWO internal waves by a MODE-ONE internal wave and a MODE-ONE eddy

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The internal tide and mesoscale eddies are prevalent in the world's oceans however the interaction between them is not well understood. Here we conduct numerical experiments to investigate the interaction between a mode-1 internal wave and a mode-1 eddy. The analytic eddy is prescribed in the interior of a square domain and, after an adjustment period, analytic mode-1 internal waves are forced at the western boundary. The mode-1 waves then propagate eastward, interacting with the eddy, and eventually get absorbed by a sponge layer at the eastern boundary.

Analysis of the resulting flow fields shows that mode-two internal waves are produced with energy flux levels reaching 8% of the forced mode-one wave. Mode-three internal waves are also produced at lower energy levels. The strength of the mode-two waves has a directional dependence which depends on the eddy. An energy budget for each mode is computed to confirm that the energy of the mode-two waves is extracted from mode-one. The conversion of energy from mode-one to mode-two has implications for enhancement of the internal wave energy cascade.

1D7.3 ID:5470 15:30

Assessing the dilution-recoupling hypothesis for the spring bloom in Bedford Basin,

Halifax

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Recently observations have been presented that indicate positive net phytoplankton growth occurs in the North Atlantic in late winter and early spring well before the shoaling of the mixed layer (Behrenfeld, Ecology 91:977-989, 2010). This notion challenges the traditional Sverdrup hypothesis, which posits that the spring phytoplankton bloom is a consequence of mixed-layer shoaling and increasing light. Behrenfeld proposed a new explanation, referred to as the dilution-recoupling hypothesis. According to this hypothesis, deep winter mixing decouples phytoplankton growth and loss rates by diluting prey (phytoplankton) and predators (zooplankton) thus resulting in reduced phytoplankton mortality and allowing net biomass accumulation despite low light. During spring, stratification enhances phytoplankton growth, but also intensifies predation losses by “recoupling” predators and prey in a smaller water volume. We are interested in testing whether this suggested mechanism explains phytoplankton observations in Bedford Basin, Halifax, using a physical-biological model in conjunction with a long-term ecological data set. The data set extends from 1994 to 2011 and contains CTD profiles and bottle samples, including chlorophyll and nutrient concentrations. The model is a simple, depth-resolved nutrient-phytoplankton-zooplankton model. We will present results from sensitivity tests that evaluate the possibility of predator-prey dilution and recoupling in Bedford Basin.

1D7.4 ID:5428 15:30

Impact of changing ocean optical properties, sea ice and cloud cover on primary production in the Arctic Ocean and its marginal seas

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The Arctic Ocean and its marginal seas are among the most affected marine regions by the changing climate. The impacts of these changes on marine ecosystems are already detectable from field-based and satellite-based measurements. While the overall increase in primary productivity (PP) has been attributed to a longer growing season resulting in enhanced light availability for photosynthesis, changes in environmental forcing of nutrient supply to the surface have been proposed as the main driver of the PP change in seasonally ice-free waters. Here we present the results of a diagnostic model used to elucidate the main drivers of PP trends over the period 1998-2010 at the pan-arctic and local (i.e., 9.28-km pixel resolution) scales. Model entries were controlled to isolate the impact of changes in ocean optical properties such as phytoplankton blooms (ocean color; OC), sea ice concentration (SIC) and cloud conditions. Results show that rising phytoplankton biomass accounted for a larger portion of the trend (3.7 TgC y-1 out of 5.1 TgC y-1) than the increase in light availability due to the loss of ice cover at the pan-arctic scale. The increase in light availability due to the shrinking sea-ice cover is partly compensated by a concurrent increase in cloudiness along the marginal ice zone, which results in a small non-significant positive trend in photosynthetically active radiation (PAR) over time (1.2 TgC y-1). At the local scale, changes in ocean optical properties, sea ice concentration and cloudiness occurred simultaneously but in different proportion: reduced sea ice explained most of the PP increase on interior shelves, while changes in ocean optical properties drove the increase in PP in permanently open waters. The reduction of light availability due to increasing cloudiness is small at the local scale but is spatially coherent and ubiquitously distributed around the marginal ice zone. Against a general backdrop of rising productivity over Arctic shelves, significant

negative trends were observed in regions known for their great biological importance such as the coastal polynyas of northern Greenland. We conclude that productivity of Arctic waters is sensitive to light availability not only due to the loss of sea ice but also to cloud conditions, and that changes in the ocean optical properties, which are detectable in several arctic regions, explained an important part of the PP trends observed.

1D7.5 ID:5435 15:30

Predicting hypoxia in the Northern Gulf of Mexico: A comparison of observed and model-simulated respiration and primary production rates

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The continental shelf of the Northern Gulf of Mexico receives large inputs of freshwater, nutrients and organic matter from the Mississippi/Atchafalaya River system and experiences widespread hypoxia in bottom waters every summer. Model estimates suggest that the spatial extent of this summer hypoxic zone has increased over the past 50 years. Oxygen sinks due to sediment oxygen demand and plankton community respiration in the water column and sources due to mixing of dissolved oxygen across the pycnocline and primary production below the pycnocline all play a role in the observed oxygen distributions in this region; however, the relative magnitudes of these components are poorly constrained. A combination of observations and models is needed to improve quantitative understanding of the underlying linkages. Here, we compare measurements of water column respiration and primary production in the region that experiences summer hypoxia with model-simulated respiration and production rates. Comparisons along gradients of salinity, water depth and along-shelf distance from the Mississippi delta will be presented. Our ultimate goal is to improve our current model to better predict the occurrence of hypoxia on the Texas-Louisiana shelf.

POSTER - Climate Change and Extreme Events / AFFICHE -Changements climatiques et événements extrêmes

Room / Endroit (Soprano), Chair / Président (Chad Shouquan Cheng), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D209.1 ID:5691 15:30

From observations to global climate models, how well do we represent extreme precipitation?

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The socio-economic implications of water resources make precipitation one of the most important variables

to predict when examining the future impacts of climate change. Though the climatological average precipitation is an important parameter, it is the extreme events that are associated with flooding and drought that have the largest societal impact. With potential changes in extreme precipitation with global climate change, our ability to observe and predict precipitation gains even greater importance. However, due to its high spatial and temporal variability, it also remains one of the harder variables to observe and predict. The increasing availability of higher temporal and spatial resolution in Global Climate Models (GCMs) is aiding our ability to study these events. To understand how these events will change in the future, we need a strong grasp of how GCMs handle them in the historical period.

This talk will take a bottom up approach to examining our ability to understand and to represent extreme precipitation. To begin, we will examine extreme precipitation in gridded station data with a decreasing station density to determine how many stations are necessary to produce extreme precipitation that is independent of sampling concerns. This will allow us to identify which regions of North America, and by inference other regions of the globe, where we can trust the observations of extreme precipitation. Intercomparisons will then be conducted between daily precipitation from gridded station data, satellite data, reanalysis, and global climate model output of the Community Climate System Model 4 and Community Atmospheric Model 5 models for extreme precipitation. Finally we will examine potential mechanisms behind deficiencies in the GCMs in the prediction of extremes when compared to the observations.

POSTER - Low-frequency variability and predictability / AFFICHE -Variabilité et prévisibilité des oscillations de basse fréquence

Room / Endroit (Soprano), Chair / Président (Hai Lin), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D8.1 ID:5810 15:30

Northern Hemisphere blocking climatology in the present and future climate as simulated by the CMIP5 models

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Northern Hemisphere blocking climatology is analysed using climate models participating in the coupled model inter-comparison project phase 5 (CMIP5). Both historical and RCP8.5 runs are examined to evaluate CMIP5 models and identify possible changes in blocking highs in the warm climate. Comparison to reanalysis reveals that most models can reproduce the Northern Hemisphere blocking climatology reasonably well although maximum Euro-Atlantic blocking frequency is generally underestimated. Significant overestimation of maximum Pacific blocking frequency is also evident in some models. In contrast, simulations forced under greenhouse gas (GHG) forcing show a weak trend of reduced blocking over the NH as compared to historical simulations, with more pronounced changes over the Pacific sector. No significant difference however is found in terms of block intensity or duration within the forced simulations. The magnitude of the model biases in simulating blocking frequency are of the order of the changes observed under future climate forcing, suggesting that improved simulation of blocking is required

for more robust predictions of blocking under global warming.

1D8.2 ID:5389 15:30

Interannual and intraseasonal variability of North American storm tracks

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Wintertime storm tracks over eastern North America are commonly characterized by two branches: 1) a northern branch of storms forming in the lee of the Canadian Rockies and tracking southeastward across the Great Lakes region and 2) a southern branch of storms forming in the lee of the Colorado Rockies and tracking toward the eastern seaboard of the United States. In this study, the authors examine the interannual and intraseasonal variability of these storm tracks in ERA-Interim reanalysis data using the Lagrangian storm-tracking algorithm first developed by Hodges (1994). The results indicate strong variability in both the location and intensity of extratropical cyclones in association with the El Niño–Southern Oscillation, the North Atlantic Oscillation, and the Pacific–North America pattern. Sudden stratospheric warmings, the Madden–Julian oscillation, and so-called central Pacific El Niño events may also play a role in the observed storm track variability. The results are compared and contrasted with previous studies, particularly those that focused on Eulerian methods.

1D8.3 ID:5633 15:30

CFS Reforecast Analysis of Intraseasonal Variability of Tropical/Extratropical Interactions

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The Madden-Julian Oscillation (MJO) is the leading mode of intraseasonal rainfall variability in the tropics (Madden and Julian, 1972). Research has shown the important effect of the MJO and Equatorial Rossby Wave (ERW) interactions on rainfall variability in the tropics. There has been increased interest in interactions between the MJO and ERW and associated signals in the extratropical flow. Intersection of ERW and the MJO, at preferred longitudes, is associated with amplified extratropical wave patterns. Numerical Weather Prediction (NWP) has long struggled with resolving and forecasting the progression of convection associated with the MJO and ERW. In order to better understand these discrepancies composite forecast maps have been generated from the Climate Forecast System (CFS) reforecast data spanning from 1 January 1982 to 31 December 2009. The CFS reforecast dataset is a high resolution reconstruction of past atmospheric conditions using the updated CFS reanalysis dataset as the models initial conditions. The composite maps focus on the extratropical flow associated with particular types of intersections between the MJO and ERW. This project identified biases in the resolution of these modes in the CFS reforecast reanalysis. The presentation will focus on the evolution of the extratropical flow associated with MJO states with convection over the Maritime Continent intersecting with an ERW crossing 110E. These maps are then compared to composite maps generated from the CFS reanalysis dataset to diagnose model bias. The resolution of the CFS reforecast analysis is limited to two and a half degrees. Results demonstrate that the CFS model struggles greatly with the spatial resolution and eastward propagation of the MJO as well as the westward propagation of the ERW. These forecast errors are simultaneously associated with errors at the 200-hPa geopotential height, ranging in amplitude from 20-60 m, caused by errors in forecasting the global extratropical flow more than several days out. The project hopes to use the knowledge gained from identifying systemic errors and biases in the model forecast, to suggest possible procedures to reduce these forecast errors, generating a better forecast when these intraseasonal interactions occur.

POSTER - Regional Climate Modelling and Climate Projections PART 1 / AFFICHE -Modélisation du climat régional et projections du climat PARTIE 1

Room / Endroit (Soprano), Chair / Président (Laxmi Sushama), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D210.1 ID:5581 15:30

A modified Monte Carlo Independent Column Approximation (McICA) methodology to represent subgrid-scale cloud variability by cloud type in the Canadian Regional Climate model (CRCM5)

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In climate models, whether they are global or regional, large-scale or meso-scale, cloud processes and their interactions with radiation are a primary source of uncertainty. This is due to the range of spatio-temporal scales involved in cloud processes and difficulties in correctly representing inhomogeneous subgrid-scale processes. Tuning of parameters is often used to reduce radiative biases that arise, in part, due to assumptions about cloud vertical overlap and horizontal inhomogeneity, which can lead to compensating biases.

The Monte Carlo Independent Column Approximation (McICA) is a method in which the radiative transfer is computed by random sampling of possible cloud states produced by a stochastic cloud generator (SCG) as opposed to including cloud structure within the radiative transfer scheme. By its nature, McICA produces unbiased radiative fluxes and heating rates with respect to the independent column approximation although it produces random errors. The SCG is used to randomly generate subcolumns of the possible cloud field (respecting the mean fields provided by the microphysics scheme) for each spectral integration point allowing a highly flexible description of the subgrid-scale cloud structure within the cloud generator.

The McICA method has been implemented in the CRCM5 (based on the Global Environmental Multi-scale or GEM model) and the SCG was altered with a first-order differentiation between the three cloud types produced by the model: stratiform; deep; and shallow convective clouds. The goal is to take into account the differing characteristics of these clouds by deriving different SCG parameters for the vertical overlap and horizontal variability of cloud water. This poster will present the step-by-step implementation from the classic McICA and SCG to the modified SGC using parameters derived from surface and satellite observations made at high spatiotemporal resolutions. The different impacts of these modifications on the cloud and water content vertical profiles will be presented.

1D210.2 ID:5459 15:30

Energy cycle of inter-member variability in a large ensemble of Regional Climate Model simulations

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Internal variability is defined as the inter-member spread between members in an ensemble of simulations performed by an RCM driven by identical lateral boundary conditions (LBC), where different members are initialised at different times. In autonomous coupled Atmosphere-Ocean Global Climate Models (AOGCM), internal variability is equivalent to natural, transient-eddy variability (TV) under steady forcing, in the limit of long simulations and large ensembles, owing to the ergodicity property. In the context of nested models, it is important to distinguish internal variability and TV because the ergodicity property is violated due to the control exerted by LBC. Possibly a better name for internal variability that avoids all ambiguity is that of inter-member variability (IV). Recent work reveals that IV arises in RCM simulations is a naturel phenomenon issued from the chaotic nature of the governing field equations. Indeed, IV perturbations are associated to energy conversions similarly to those in weather systems. Fluctuations available potential energy are generated by certain physical processes, and this energy is converted back to fluctuation kinetic energy. In this study, we perform an energy cycle of IV for an ensemble of RCM simulations by decomposing each atmospheric parameter into contribution from mean and deviation. We use a large ensemble of 50 one-year simulations that differ only in the ICs. The first result of our approach will be presented.

1D210.3 ID:5844 15:30

Developing glacier mass balance hindcast for selected glaciers in the Coast Mountains of western Canada using distributed glacier mass balance model

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Glacier mass balance hindcasts are developed for selected glaciers in the Coast Mountains of western Canada. Mass balance hindcasts are developed using glacier mass balance (GMB) model which is based on distributed surface energy balance approach. The GMB model is physically based and developed particularly for its application using meso-scale climate fields. The model has been tested at Place glacier in the southern Coast Mountains over the period of 1980 to 2008 using climate fields obtained from 8 km meso-scale RAMS model. Simulated glacier mass balance over the test period is comparable with the observations suggesting the potential application of meso-sacle climate fields for distributed glacier mass balance modeling in the Coast Mountains. Works are underway to run the model in future for the same glaciers in the Coast Mountains using climate scenarios (A2 SERES emission scenario) from CGCM3.1, a third generation GCM from Canadian Centre for Climate Modelling and Analysis (CCCma). Glacier mass balance hindcast will help understand the response of glaciers to climate variation in the past where as the future model run will provide a regional overview of future glacier mass balance in the region. The model can be used to estimate mass balance of a large number of glaciers in the region which remained unmonitored due to their remoteness. Future glacier mass balance scenarios obtained from the model can be useful for formulating future water management policies and adaptation strategies to cope with challenges associated with climate change and glacier recession.

1D210.4 ID:5612 15:30

A method for statistically downscaling coarse-resolution model results to predict

future climate changes in temperature

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A method for statistically downscaling coarse-resolution model results to predict future climate changes in temperature is proposed. This method is based on the fact that many atmospheric variables such as maximum and minimum daily temperature (Tmax and Tmin) have strong average seasonal cycles, which are the same each year. The method consists of three major steps: First, the average seasonal cycle is removed. Second, a Principal Component (PC) regression model between daily Tmax and Tmin and NCEP PCs is develped and validated for thirty four Eastern Canada sites. Output from the CGCM3 is then used to make future projections at each site. Projections suggest many locations will have a mean temperature nearly five degrees warmer by the end of the century.

1D210.5 ID:5766 15:30

Performance of the lake model FLake in the Canadian Regional Climate Model, version 5 simulations over two CORDEX domains – North America and Africa.

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The Canadian Regional Climate Model, version 5 (CRCM5), has been used for simulating the climate over two CORDEX domains for the 1989-2008 period, using the ERA-Interim reanalysis boundary forcing. The interactively-coupled lake model FLake was used for simulating the thermal regime of lakes in these experiments. Both simulations were performed with identical lake model settings and initialization conditions. The performance of the coupled FLake model for different climatic regions, going from arctic to equatorial conditions, was assessed by comparing with observations, where available. It was shown that for a wide range of lakes and climate zones the FLake model is capable of reproducing satisfactorily the water surface conditions. Limitations of the model and possible application of the coupled FLake model to inland seas in different climate zones will also be discussed.

1D210.6 ID:5529 15:30

A Copula-based Multivariate Analysis of Canadian RCM Projected Changes to Flood Characteristics for Québec, Canada

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Flood events have significant economic and social consequences in Québec, and therefore, better understanding of flood characteristics (i.e. flood peak, volume and duration) from a multivariate viewpoint is essential in the context of a changing climate. Conventional univariate analyses can be insufficient for hydrologic design and flood management, since flood characteristics are random in nature and mutually correlated. Multivariate analysis of flood events can be performed using copulas. In this paper, in a context of changing climate, we followed a general approach to derive appropriate bivariate joint probabilities of flood characteristics by exploiting Archimedean copula and a set of parametric distributions for modelling

individual characteristics of flood events. In the analysis, daily streamflows derived from an ensemble of ten 30-year transient climate change Canadian RCM simulations, of which five correspond to current climate (1970–1999) and the remaining five are the matching simulations for the future climate (2041–2070), are used to study projected changes to joint probabilities of flood characteristics corresponding to selected return periods for 21 Québec basins. The results of projected changes to joint probabilities of flood characteristics for the 2041–2070 period with respect to the 1970–1999 reference period show increases to at least one out of three flood characteristics for La Grande Rivière, Grande rivière de la Baleine and Natashquan basins and at least two out three flood characteristics for Romaine and southeastern part of Rivière des Outaouais basins corresponding to selected return periods (e.g. 5- 10-, 20-, 30-, 50- and 100-yr) suggesting the vulnerability of those basins to climate change.

1D210.7 ID:5821 15:30

Active layer thickness (ALT) data as validators of simulated permafrost change

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With climate change projected to affect Arctic regions particularly strongly in the coming decades, there is a general need to conduct climate simulations in these regions to estimate the impact of higher air temperatures on the underlying permafrost. Validating simulations of northern climate is made more difficult than those in temperate regions due to the relatively low abundance of meteorological data. Active layer thickness (ALT) has not only become a metric for the field measurement of permafrost change, but can serve as a validator of climate simulations attempting to quantify permafrost change. While direct measurement of ALT began over 20 years ago with the creation of the Circumpolar Active Layer Monitoring (CALM) project, there hasn't been sufficient data for model validation until recently. The primary focus of this work is the assessment of the CALM dataset as a validator for permafrost simulations. There are, however, areas that are not adequately covered by CALM data; we therefore also examine the extraction potential of ALT data from subsurface temperature data obtained from boreholes and automated subsurface temperature recording stations. Results indicate that existing boreholes are generally unsuitable for ALT inferences due to their relatively coarse vertical resolution, and sporadic logging dates that fail to accurately capture the timing of summer maximum thaw events. Automated stations offer much promise due jointly to their higher vertical resolution and systematic temporal coverage. We also examine the potential for numerical, one-dimensional simulation of the subsurface thermal regime, and subsequent inference of ALT using both surface air temperature (SAT) and ground surface temperature (GST) boundary conditions.

1D210.8 ID:5964 15:30

Analysis of streamflow characteristics over northeastern Canada in a changing climate

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An analysis of streamflow characteristics (i.e. mean annual and seasonal flows and extreme high and low flows) in current and future climates for 21 watersheds of north-east Canada covering mainly the province of Quebec is presented in this article. For the analysis, streamflows are derived from a 10-member ensemble of Canadian Regional Climate Model (CRCM) simulations, driven by Canadian Global Climate Model

coupled global simulations, of which five correspond to current 1970–1999 period, while the other five correspond to future 2041–2070 period. For developing projected changes of streamflow characteristics from current to future periods, two different approaches are used: one based on the concept of ensemble averaging while the other approach is based on merged samples of current and similarly future simulations following multiple comparison tests. Verification of the CRCM simulated streamflow characteristics for the 1970–1999 period suggests that the model simulated mean hydrographs and high flow characteristics compare reasonably well with those observed, while the model tends to underestimate low flow extremes. Results of projected changes to mean annual streamflow suggest statistically significant increases nearly all over the study domain, while those for seasonal streamflow show increases/decreases depending on the season. Two- and 5-year return levels of 15-day low flows are projected to increase significantly over most part of the study domain, though the changes are small in absolute terms. Based on the ensemble averaging approach, changes to 10- and 30-year return levels of high flows are not generally found significant. However, when a similar analysis is performed using longer samples, significant increases to high flow return levels are found mainly for northernmost watersheds. This study highlights the need for longer samples, particularly for extreme events in the development of robust projections.

1D210.9 ID:5577 15:30

What do climate modelers believe in?

Ramon De Elia
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Climate models are numerical algorithms based on discretizations of very well established physical laws (e.g., those of fluid dynamics and thermodynamics), as well as on some other less successful descriptions of sophisticated mechanisms (e.g. parameterization of surface processes). As an aggregate of formulations with several levels of precision and highly non-linear behaviour, the climate model stands as an operator with a priori unforeseeable behaviour. That is, given the code of the model, nothing but the running of the model can establish model results. This is but one of the characteristics of climate modelling that makes it not only an exceedingly complex activity but also a science whose set of fundamental beliefs is difficult to formulate and communicate.

There are a number of beliefs within the community that have varied degrees of acceptance --some are considered truths by everyone involved, some divide the community in schools of thought, and some are so unrecognized that most of us do not even have a conscious position about them. In this presentation a number of beliefs regarding the science of climate modelling will be discussed, a formal language will be presented that simplifies their communication, and the importance of spending research time probing the deep beliefs of climate modelers will be addressed.

POSTER - Climate Data Homogenization and Trend Analysis / AFFICHE -Homogénéisation des données climatologiques et analyse de tendances

Room / Endroit (Soprano), Chair / Président (Lucie Vincent), Date (29/05/2012), Time / Heure

(15:30 - 16:30)

1D211.1 ID:5404 15:30

Homogenization process of daily average air temperature

Livia Leskova , *Oliver Bochnicek* , *Peter Kajaba*
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Homogenization process is complicated sequence of steps which leads to correction of inhomogeneous data. For needs of one of our projects, it was necessary to correct daily data of average air temperature from period 1961 - 2010. Whole process was processed in program ProClim and tests of homogenity (e.g. T-test, Bivariate test, etc.) were provided in program AnClim. There was necessary to use proper settings and parameters, because they depend to meteorological elements. There were corrected daily data, but detection of inhomogenities was processed on monthly data. Expected inhomogenities were compared with metadata and only relevant of them were taken in consider during adjustment of daily data. It is recommended to repeat whole homogenization cycle at least three times. Our poster shows brief steps which were done to get homogeneous daily data of average air temperature.

POSTER - General Climate Science / AFFICHE - Les sciences du climat en général

Room / Endroit (Soprano), Chair / Président (Ramon de Elia), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D9.1 ID:5282 15:30

The impact of using different modern climate datasets in paleoclimate reconstructions

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In this study we show how using different modern climate datasets can affect a pollen-based reconstruction of mean temperature of the warmest month (MTWA) of the last two thousand years for North America. We used both station and re-analysis data for several different time periods to calibrate the reconstructions. Some caution is advised for performing climate reconstructions as some modern datasets may have a warm or cold bias (or regional bias) depending on the dataset and time period used. An ultra-high resolution gridded climate dataset may only be useful if the calibration sites used in the study have at least the same spatial precision as the gridded dataset. And finally, we reconstruct the MTWA using all modern datasets to within +/-0.01ºC by using an average of all curves, demonstrating the robustness of the procedure used. Using an average of different modern datasets may reduce the impact of uncertainty of paleoclimate reconstructions.

1D9.2 ID:5731 15:30

Changes in the Summer Clearing of Sea Ice in Northeastern Baffin Bay, 1996-2011

David Fissel [1], *Mar Martínez De Saavedra Álvarez* [2], *Todd Mudge* [2], *Nilgun Kulan* [2], *Keath Borg* [2], *Ed Ross*

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The sea ice concentrations in northeastern Baffin Bay have undergone major reductions over the past 31 years (1981-2011) in the eastern portion of Baffin Bay, from Disko Island off central west Greenland to Melville Bay in Northern Greenland. Since the late 1990s, there has been a very large reduction in total ice concentration in the month of July. Changes in the sea ice regime are important to the marine ecosystem of Baffin Bay, as well as for shipping and offshore oil and gas exploration. The dates of ice clearing, along with other characteristics of the ice free season, were derived from the weekly Canadian Ice Service Digital Archive ice chart data on ice concentrations and ice types. Prior to the late 1990s, ice clearing usually occurred in mid-July. From 1999 to 2011, the mid-July ice concentrations have been much lower and exceeded two-tenths for only two to four years out of 13. The average break-up date over the past 13 years has occurred in late June, which is equivalent to an advance in ice clearing of three weeks from the earlier period. The trend toward reduced ice concentrations in the central areas of northeastern Baffin Bay persists through the summer months and into early autumn. The changes in the early summer ice regime began quite abruptly in 1996-1998, prior to which, much higher ice concentrations prevailed back to the mid-1980s. This change coincided with a marked decrease in the winter North Atlantic Oscillation (NAO) index, computed as the normalized difference in sea level pressure between southwest Iceland and Gibraltar. The possible underlying causes of the reduced sea ice concentrations, on a regional scale, due to atmospheric processes in eastern Baffin Bay have been examined through an analysis of NCEP Reanalysis-2 winds and air temperature over this extended period of time.

1D9.3 ID:5402 15:30

Effects of climate change on food production in Northwest India

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Northwestern region comprising of the provinces of Punjab, Haryana and Himachal Pradesh is the greatest food bowl of India contributing to its food security. In the past, numerous studies have been conducted by agriculturalists, scientists and economists on the adverse effects of climate change on crop growth and yields in India {Aggarwal P.K., et.al. 2008; Ahmad J., et.al. 2011; Chaudhry A., et.al. 2007; Kumar K., et.al.2001; Malli, et.al. 2006 and Sinha, et.al.1994} although considering a time span of just a few decades for their studies. The main objectives of our present study are: (a) To show overall trends of temperature and rainfall in Northwest India from 1901 to 2010. (b) To study their effects on agricultural production in the region during this period. Rice and wheat, the two major crops of summer and winter season respectively are considered in this work. These two crops have known to be very sensitive to climatic changes. Wheat is vulnerable to an increase in maximum temperature while rice is sensitive to an increase in minimum temperature. To achieve the aforementioned objectives, secondary data have been collected for the mean monthly rainfall, maximum and minimum temperatures for past 110 years (1901-2010){Indian Meteorological Department, Pune}. Plotting the climatic trends depicts that both the maximum and minimum temperature have been increasing at annual, summer and winter time scales although with different rates. Rainfall varied at monthly scales while no significant change has been observed at annual and seasonal scales. The analysis for food grain production shows no crucial effect of climatic conditions on food grains production from 1901 to 1960 but afterwards it has substantially decreased. This effect is more pronounced on the yield of wheat per hectare as compared to rice. The decline in wheat production is likely to challenge the food security of the country.

1D9.4 ID:5299 15:30

Assessment of dissimilarity metrics for ranking spatial analogues

Patrick Grenier [1], *Annie-Claude Parent* [2], *Diane Chaumont* [1], *David Huard* [1]
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Spatial analogue methodologies involve identifying locations whose recent-past climate is similar in some aspects to the future climate of a reference location. Use of spatial analogues may allow for exchange of knowledge between decision makers, thus potentially aiding development or improvement of adaptation strategies to climate change. In the process of identifying analogues, one key step is the quantification of the dissimilarity between two climates separated in time and space, which implies the choice of a metric among several possibilities. Unfortunately, this choice is often not justified in spatial analogue studies, most likely in part because related uncertainty has not been investigated thoroughly. In this study, we present our attempts to find rationales for this choice, by investigating the performance of six dissimilarity metrics in the context of spatial analogues : the standardized euclidean distance, the Kolmogorov-Smirnov statistic, the nearest-neighbor distance, the Zech-Aslan energy statistic, the Friedman-Rafsky runs statistic and the Kullback-Leibler divergence. Our case study involves the use of numerical simulations performed with the Canadian Regional Climate Model (CRCM_v4.2.3), from which 3 annual indicators (total precipitation, heating degree-days and cooling degree-days) are calculated over 30-year periods. The reference climate is that of Montreal over 2041-2070, and analogues are searched over Southeastern Canada and Northeastern United States over 1971-2000. Performance of each individual metric is assessed in terms of representativeness of the metrics ensemble, ability to avoid compensation of departures for individual climate indicators, and sensitivity in specific perturbation tests. Moreover, uncertainties stemming from the metric choice and the simulation choice are compared.

POSTER - Variability in the northwest Atlantic and northeast Pacific, and its relation to atmospheric forcing / AFFICHE Variabilité dans l'Atlantique Nord-ouest et le Pacifique Nord-est et relation avec les forçages atmosphériques

Room / Endroit (Soprano), Chair / Président (W.R. Crawford), Date (29/05/2012), Time / Heure (15:30 - 16:30)

1D212.1 ID:5601 15:30

Recent and Long-Term Variability in Oceanographic Conditions in the Labrador Sea

Igor Yashayaev , *John Loder* , *Blair Greenan* , *Kumiko Azetsu-Scott* , *Glen Harrison* , *Erica Head* , *Bill Li*
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Recent inter-annual and decadal-scale variability in the physical, chemical and biological oceanography of the Labrador Sea is described and interpreted based on the annual spring surveys of DFO's Atlantic Zone Off-Shelf Monitoring Program (AZOMP), Argo float and remote sensing data, and complementary larger-scale datasets. The variables include temperature, salinity, stratification, sea level gradients, dissolved oxygen, nutrients, ocean carbon, chemical tracers, ocean colour, bacteria, phytoplankton and zooplankton. Argo data are used to resolve the seasonal variability in the physical oceanographic variables over the past decade. Longer-term variability in the temperature and salinity of various layers is examined using additional earlier datasets from OWS Bravo and other sources, including some from the 1930s. Indices from these datasets are used to describe multi-decadal variability of the inflowing waters in the subpolar gyre and the Atlantic Meridional Overturning Circulation (AMOC), and of local water mass modification by deep convection. The variability is interpreted in relation to the strong natural atmospheric variability (e.g. North Atlantic Oscillation) in the region, and the possible emergence of anthropogenic climate change signatures.

Colloquium on Climate Services for vulnerable societies PART 3 / Colloque sur les services climatologiques destinés aux sociétés vulnérables PARTIE 3

Room / Endroit (Grand salon A), Chair / Président (Philippe Gachon), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E4.1 ID:5675 INVITED/INVITÉ 16:30

Providing climate change scenarios for end-users, Modus Operandi at Ouranos

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Planning and adapting to changing climate requires credible information about the magnitude and rate of projected changes. The Climate Scenarios Group at Ouranos specializes in the development and production of climate scenarios adapted to users' needs based on state-of-the-art methodologies, climate models and observational data. A major thrust of this work is the characterisation and communication of the uncertainties involved in scenario construction. Over a period of several years, Ouranos have developed a consistent method for scenario generation and communication. First, an objective approach is applied to select representative sub-sets of projection ensembles that include the model- and emission-based uncertainties without over-burdening the user with information. Second, Ouranos have developed a suite of post-processing empirical approaches appropriate to the particular variables and needs of impact and adaptation studies. Finally, a major effort has been devoted to developing effective ways to communicate scenarios. Our method of scenario generation aims at being transparent and rigorous (i.e. by taking account of the major sources of uncertainty), but at the same time being simple enough that results can be readily understood by end-users. This presentation will provide an overview of the scenario generation process developed at Ouranos with examples drawn from a wide range of user needs.

1E4.2 ID:5779 INVITED/INVITÉ 16:45

SNC-Lavalin vs l'adaptation et le renforcement des capacités face aux changements et aux aléas climatiques

Luc Vescovi , *Myrzah Bello* , *Jean Luc Allard*
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Face aux phénomènes des changements climatiques (CC) et de la lutte contre les aléas climatiques extrêmes, les communautés apportent de plus en plus des réponses concrètes en termes de mise en place de stratégies de gestion et de gouvernance des infrastructures et de l'environnement. De nombreux plans et stratégies d'adaptation ont été proposés ces dernières années. Il s'agit maintenant d'aller un pas plus loin, de prendre des décisions en matière d'infrastructures, d'urbanisme, de santé publique et d'assurance, ainsi que de planifier et de gérer les risques tant au niveau des collectivités locales qu'à l'échelle internationale. Des mesures concrètes d'adaptation ou de gestion des risques naturels d'origines climatiques doivent dorénavant être implantées concrètement. L'accord atteint à Durban (lors du COP 17) a permis de donner le coup d'envoi de la mise en place du fonds vert pour le climat. Celui-ci contribuera d'ici 2020 à la mobilisation des 100 milliards de dollars par an promis par les pays développés pour aider les pays en développement dans leur action contre le changement climatique et ses effets.

L'adaptation fait, par définition, appel à de nombreuses expertises de domaines aussi variées que les services climatiques, l'analyse des risques socio-économiques et environnementaux, la planification à l'implantation d'actions concrètes ainsi que la visualisation et le développement d'outils d'alertes. Afin de bien répondre à ce marché en plein développement et de bien positionner ses champs d'interventions, SNC-Lavalin a tous les atouts en main et se place comme un leader en offrant un éventail d'expertises essentielles pour répondre aux projets (en adaptation) à venir. La compagnie est toutefois consciente des éléments à renforcer afin de mieux définir sa niche d'intervention. Travailler en partenariat avec des tiers pour offrir des services complémentaires est essentiel. Ainsi, les réflexions en cours au sujet des services climatologiques relativement au nouveau cadre mondial de l'OMM pour ceux-ci lui sont d'un grand intérêt.

1E4.3 ID:5548 INVITED/INVITÉ 17:00

Le Programme de surveillance du climat au Québec

Éric Larrivée
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Le Service de l'information sur le milieu atmosphérique (SIMAT) a développé une expertise sur la surveillance et l'acquisition de connaissances du milieu atmosphérique. Pour suivre l'évolution de la qualité de l'air, des précipitations et du climat, il coordonne la planification, la gestion et l'exploitation de trois programmes de surveillance. Le Programme de surveillance du climat (PSC) compte 361 stations, dont 285 sont opérées par des observateurs. Grâce à son expertise humaine (technique et professionnelle), le SIMAT effectue la collecte et la gestion des données recueillies dans l'ensemble de ses réseaux, procède à leur analyse et interprétation, tout en les soumettant à de rigoureux processus de contrôle de la qualité. Un important projet de modernisation de ces réseaux est actuellement en cours dans le cadre du plan d'action gouvernemental sur les changements climatiques.

Le PSC a pour objectif la production en temps opportun de données climatologiques, lesquelles sont utilisées dans les activités gouvernementales ayant trait à la sécurité des populations, au développement durable dans des activités d'incidences économiques majeures et à la connaissance à long terme du climat. Le SIMAT participe au suivi d'ententes signées par le Québec afin d'assurer une meilleure coordination de l'utilisation des données. Il collabore à la mise en œuvre de programmes d'envergure nationale et internationale tels le Réseau météorologique coopératif du Québec et l'assurance-récolte de la Financière agricole du Québec.

Le SIMAT a développé une expertise-conseil qu'il met au service de ses partenaires et de nombreux organismes gouvernementaux, que ce soit en fournissant des données à la pièce ou en temps réel, en balisant leur utilisation ou en organisant des activités de transfert de connaissances. À lui seul, le service Info-Climat traite près de 4 500 demandes spécifiques d'entreprises privées (assureurs, avocats, firmes d'ingénieurs, etc.), d'universités et de particuliers portant sur l'obtention de données ou la production d'expertises pointues.

1E4.4 ID:5420 INVITED/INVITÉ 17:15

Attributes and Challenges of Regional Climate Service Delivery: The Pacific Climate Impacts Consortium Experience

Alex Cannon , *Francis Zwiers* , *Cassbreea Dewis*
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The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria. The main role of PCIC is to conduct quantitative studies on the impacts of climate change and variability in the Pacific and Yukon Region of Canada. This work provides information needed to develop plans for reducing the risks associated with climate variability and change. Through the service oriented delivery of this information, PCIC plays an important bridging function between climate research and the practical application of that knowledge by decision makers. This talk draws upon the PCIC experience operating as part of a larger network of climate research organizations and climate information stakeholders. Topics to be explored include PCIC's service objectives, the evolution of the climate service delivery system in Canada, desirable characteristics of a regional climate service centre, and the coming challenges.

1E4.5 ID:5739 INVITED/INVITÉ 17:30

Climate Services of Tomorrow: The Communication Challenge

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As the leading provider of weather information to Canadians, The Weather Network and MétéoMédia will play an important role in the delivery of tomorrow's climate services. A significant challenge in delivering these services is effective communication to end users.

Serving both consumers and commercial clients, The Weather Network and MétéoMédia see growth potential for climate-related products across television, web and mobile platforms. Geographical Information Systems have potential to create relevant products for customers that assist in learning and decision-making. However, education of end users will be essential to ensure successful communication of these climate products. Lessons learned from communicating the concepts of uncertainty and risk in traditional weather forecasts may be applicable to more abstract climate data and predictions.

DA II: Data Assimilation Systems / Systèmes

Room / Endroit (Grand salon B), Chair / Président (Carolyn Reynolds), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E1.1 ID:5520 INVITED/INVITÉ 16:30

An OSSE-based evaluation of 4D-Ensemble-Var (and hybrid variants) for the NCEP GFS

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The capability to incorporate flow-dependent, ensemble-based representations of a background error covariance matrix into variational data assimilation has recently been developed and tested for use in the GSI by utilizing the extended control variable method. Experimentation using a coupled, dual-resolution 3DVAR-EnKF hybrid system with the NCEP Global Forecast System model has shown that utilizing the hybrid paradigm can yield substantial forecast error reduction relative to a 3DVAR-based control system. In dual resolution experiments, the ensemble is run at a coarser resolution relative to the high-resolution, deterministic (hybrid) analysis and forecast components. A hybrid system is scheduled to become operational as part of the NCEP global data assimilation system in April 2012.

To further understand the impact of the hybrid data assimilation systems on the quality of analyses and subsequent forecasts, experiments can be carried out using an observing system simulation experiment (OSSE). By utilizing an OSSE and having access to a truth, it is possible to better understand how and why the supplementary ensemble information is reducing analysis and forecast error.

Experiments will be carried out using the NCEP GFS model and GSI-based dual-resolution hybrid by using the Joint OSSE nature run and simulated observations. In addition to hybrid 3DVAR-EnKF experiments, additional runs will be made to evaluate the extension to so-called 4D-ensemble-var (and its hybrid variants). The importance of supplementing the ensemble with a full-rank (time-invariant) static estimate as well as including initialization and balance constraint operators within the variational framework will be presented. Lastly, a brief summary of hybrid-related plans for the NCEP operational global system (present and future) will be given.

1E1.2 ID:5283 17:00

Impact of the 4D-Var Regional analysis system on the new Canadian RDPS system

Luc Fillion , *Monique Tanguay* , *Ervig Lapalme* , *Mateusz Reszka* , *Manon Lajoie* , *Stephen Macpherson* , *Judy St-James* , *Bin He* , *Paul Vaillancourt* , *Alain Patoine*
EC
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We present results of extensive evaluations of the newly developed Regional 4D-Var analysis system at Environment Canada (EC) in Dorval in support of the Regional Deterministic Prediction System (RDPS). As an extension of the currently operational Regional 3D-Var analysis, we now run a 4D-Var scheme that allows coherent evolution in time of analysis increments within the time assimilation window. Spatial resolution of the analysis increments are now at 65 km with a 15 minute data binning as compared to 100 km resolution and 45 minute binning used operationally. As a new data source, ground based GPS are now

assimilated in the 4D-Var system. Many computer optimization have been achieved so as to maximally exploit the newly available IBM Power 7 computers in Dorval.

This 4D-Var system is coupled with a new 10 km GEM model (replacing GEM-15 km) with some upgrades of physical processes. Specific performances of this latter component of the system are given in a companion presentation at the conference.

1E1.3 ID:5464 17:15

Environment Canada's Regional Ensemble Kalman Filter: Some preliminary results

Seung-Jong Baek [1], *Luc Fillion* [2], *Peter Houtekamer* [2]
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[2] Meteorological Research Division, Environment Canada
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A regional ensemble Kalman filter data assimilation system (regional EnKF) is being developed for regional applications at the Canadian Meteorological Center. The regional EnKF is coupled with the global EnKF to obtain boundary conditions. An ensemble of 96 members based on the regional GEM-LAM forecast model at 20 km horizontal resolution is being used. The regional EnKF is intended to serve as a basis for the regional ensemble prediction system (REPS) but will also be used for comparisons against the upcoming operational deterministic regional 4dvar system.

In this talk we will describe the structure of the REPS; the regional deterministic prediction system (RDPS); and present preliminary results using the regional EnKF.

1E1.4 ID:5610 17:30

Adaptation of the Gridpoint Statistical Interpolation (GSI) for hourly cycled application within the Rapid Refresh

Ming Hu , *Stan Benjamin* , *Steve Weygandt* , *Haidao Lin* , *Curtis Alexander* , *Patrick Hofmann* , *David Dowell*
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The Rapid Refresh (RAP) is an hourly updated mesoscale analysis and prediction system developed by the NOAA Earth System Research Laboratory (ESRL) that is scheduled to replace the Rapid Update Cycle (RUC) at the National Centers for Environmental Prediction (NCEP) as a very short-range numerical weather guidance system for aviation, severe weather, and general forecasting applications.

For the analysis, RAP uses the Gridpoint Statistical Interpolation (GSI), which is mainly developed at NCEP for operational use, but also is supported by the Developmental Testbed Center as a community data analysis system. The RAP version of the GSI is based on a revision of community GSI trunk with many additional features and enhancements for special RR applications. Most of these features and enhancements have been used in RUC for many years as key techniques to improve short-range forecasts for the aviation and severe weather guidance.

In this talk, I will summarize these special features in GSI that are developed by NOAA/ESRL/Global System Division in the past several years for the RAP application. These features include the digital filter initialization (DFI)-based radar reflectivity assimilation, generalized cloud analysis package, and surface data assimilation techniques, and optimization of background error covariance for RAP application. In addition, I will provide an assessment of the performance of the GSI for the RAP hourly updated short-range forecast application and document the analysis and forecast impact for various observing systems. Lastly, an overview of future plans, including an eventual transition to an ensemble-hybrid-based assimilation system is introduced.

1E1.5 ID:5452 17:45

Integration of NCAR DART-EnKF to ATEC multi-model, multi-physics and mutli-perturbantion ensemble-RTFDDA (E-4DWX) forecasting system

Linlin Pan [1], *Yubao Liu* [1], *Gregory Roux* [1], *Wanli Wu* [1], *Yonghui Wu* [1], *Jason Knievel* [1], *John Pace* [2], *Scott Halvorson* [2], *Frank Gallagher* [2]

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This study integrates NCAR (National Center for Atmospheric Research) DART-EnKF (Data assimilation research testbed-ensemble kalman filter) system to the ATEC (US Army Test and Evaluation Command) operational multi-model, multi-physics and multi-perturbation ensemble-RTFDDA (ensemble real time four dimensional data assimimiation) four-dimensional weather system (E-4DWX). E-RTFDDA is an innovative mesoscale real-time ensemble data analysis and forecasting system which contains diverse ensemble perturbation approaches. A 30-member E-RTFDDA system with three nested domains with grid sizes of 30, 10 and 3.33 km has been running on a Department of Defense high-performance computing platform since September 2007. It has been applied at different US geographical locations successfully.

This work enhances E-RTFDDA to include the NCAR DART EnKF tools. The enhanced system allows the DART EnKF to take the advantages of E-RTFDDA by deriving error covariance using the multiple perturbation E-RTFDDA forecasts; and meanwhile, it strengthens E-RTFDDA ensemble initial conditions perturbations with the EnKF mean updates and a subset of EnKF perturbation members to improve the ensemble prediction. This system integrates WRF (weather research forecast model)-ARW (advanced research WRF), WRF-NMM (non-hydrostatic mesoscale model system), and MM5 together, and different data assimilation schemes, which include both NCAR DART EnKF system and NCAR RTFDDA system as well. The results of the system performance and sensitivity studies will be presented.

Operational Weather Prediction (WAF) PART 2 / Prévision météorologique opérationnelle (WAF) PARTIE 2

Room / Endroit (Grand salon C), Chair / Président (John Brown), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E2.1 ID:5671 16:30

A unified cyclone tracking system

Ronald Frenette [1], *Jean-Francois Caron* [2], *Rares Gheti* [1], *Philippe Gachon* [1], *Rabah Aider* [1], *Stephane* [1]

Gagnon
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A hurricane and tropical storm detection algorithm was combined with an extra-tropical cyclone tracking technique developped by M.R. Sinclair (1997). This unified system allows to objectively follow and identify different kinds of synoptic cyclones, as well as extra-tropical transitions, using gridded outputs from analyses or prognoses from deterministic and ensemble forecasting systems. The detection and tracking methods will be explained and some forecasting and climatology applications will be presented.

1E2.2 ID:5407 16:45

Estimating Snowfall Rate Using WKR Polarimetric Radar Data

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Every winter, snow storms have moderate-to-severe impact on airports, cities, and communities at higher latitudes. Many studies have showed the ability of polarimetric radars to improve rainfall estimation (QPE), but no similar studies have been found focusing on snowfall estimation (Snow Water Equivalent; SWE). To evaluate the ability of polarimetric radars to estimate SWE, data from the well calibrated dual-polarized King City radar (WKR) in Toronto, Ontario, were used. The polarimetric variables used in this study are equivalent radar reflectivity (Zeh), correlation coefficient (ρhv), differential reflectivity (ZDR), and specific differential propagation phase (KDP). Snowfall measurements were obtained from a field campaign conducted in Oakville, Ontario, for the period January to April, 2011. The collected data showed a distinct positive exponential relationship between Zeh and ρhv. No direct relationship was noticed between ZDR and ρhv or Zeh. Also, at higher Zeh and ρhv, i.e. heavy snowfall rates, values of ZDR tend to be very low. A non-linear regression analysis method was used to fit a variety of power-law estimators using the surface observations and Zeh, ZDR, and KDP from WKR. To validate the new power-law estimators, SWE data from a GEONOR T-200B, fitted with a Nipher shield, at Pearson International Airport (CYYZ) were used after being quality controlled for wind correction and minimum SWE. The obtained power law estimators, S(Zeh-ZDR) and New (Zeh-S), showed better results (meteorologically and hydrologically) when compared to the currently employed (Zeh-S) relationship with an emphasis on moderate-to-heavy snowfall events. Although polarimetric radars have the ability to show microphysical properties of snow habits, the S(Zeh-ZDR) estimator showed very little deviation from the non-polarimetric one, i.e., New (Zeh-S), which can be attributed to a small weight given to ZDR in the estimator which in turn was due to the low sensitivity of ZDR to snow habits at that height.

1E2.3 ID:5702 17:00

Extreme precipitation events in the Southeast US: A preliminary investigation of operational forecast challenges related to moisture sources and transport

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The Southeast US experiences extreme precipitation from a number of different phenomena, making

quantitative precipitation forecasting (QPF) in this region especially challenging. To improve predictive capabilities in both human- and model-generated forecasts through better understanding of key moisture sources and transport mechanisms, preliminary experiments associated with the Hydrometeorologyl Testbed – Southeast (HMT-SE) project are proposed using both observations and numerical modeling methods.

Extreme precipitation events in the Southeast US may vary by (i) weather system type (e.g., organized and isolated convection, extratropical cyclones, land-falling tropical systems, orographically generated or -modulated systems), (ii) source of moisture (e.g., Gulf of Mexico, Caribbean Sea, Atlantic Ocean), and (iii) physical processes involved in moisture transport (frontal dynamics, diabatic enhancement processes, direct tapping of tropical moisture; such variability further complicates the predictability of extreme precipitation events in this region.

In this study, observations and forecasts of historical extreme events are first used to construct climatologies of (i) observed extreme events, and (ii) observed QPF performance for such events. These climatologies will then be cross-analyzed to identify atmospheric patterns associated with enhanced or diminished predictability, as well as sub-classify the extreme precipitation events and associated forecast challenges. Numerical modeling studies are approached from two perspectives as well. Model-based case studies of extreme precipitation events are used for diagnostic analysis including moisture budgets and trajectory analysis. In later stages of this work, modeling efforts will focus on a real-time operational forecasting framework, collaborating with others in the NOAA Testbed community to evaluate questions of predictability, model physics, resolution dependencies, and, potentially, the impacts of assimilating data collected from the HMT-SE Pilot Study (planned for Spring 2013). The proposed experiments will focus on improving understanding of operationally-relevant aspects and definitions of moisture sources and transport mechanisms (e.g., low-level jets, atmospheric rivers, pre-frontal warm conveyor belts) and their relationship to extreme precipitation.

1E2.4 ID:5286 17:15

Return of the snowburst: A diagnostic examination and predictability of the southern Alberta wintertime convection event of 3 December 2011

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Snow squalls are traditionally thought to occur primarily in lake-effect snow regions. However, recent research and the development of a new snowsquall (non-lake effect) warning by Environment Canada has drawn attention to short-lived snow bursts that do not occur in close proximity the Great Lakes are associated with the passage of an arctic front. Despite the short duration of these events, snow bursts can still have a substantial impact on human life and property. These events are typically characterized by small snow accumulations, but can cause very low visibilities and rapidly deteriorating road conditions, both of which are a major hazard to motorists. On the afternoon of 3 December 2011, a snow burst moved through the Calgary, Alberta (CYYC) metro area and created havoc on area roads, resulting in collisions and injuries. Preliminary results show that this event, similar to a snow burst event in Ottawa nearly two years earlier, was associated with the passage of an arctic front. While convection or squall lines are not common in January in Canada, previous work has shown that snow bursts are associated with strong low-level frontogenesis, in the presence of steep mid-level lapse rates and conditional symmetric instability. Using reanalysis and numerical model data, we compare and contrast the synoptic-scale and mesoscale conditions of the Calgary snow burst with the Ottawa snow burst of January 2010. In particular, we highlight the lack of an upstream upper-level trough in the Calgary case, and explore the possible role that upslope flow played in the formation and maintenance of the Calgary event. Finally, the predictability of the Calgary event will be explored using NCEP NAM and GFS model data.

1E2.5 ID:5515 17:30

A Preliminary Evaluation of Heavy Snow Conceptual Models for East Vancouver Island

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Due to its unique geographical location, the East Vancouver Island (EVI) region of British Columbia (BC) is prone to heavy snow. These heavy snowfalls pose significant forecasting challenges for the operational meteorologists. One of the greatest difficulties is to distinguish a weather system that produces extreme snow amounts from one that produces modest amounts. Based on the Pacific Storm Prediction Centre 10-year (January 2000- December 2009) snow warning dataset (81 snow events), four principal weather patterns for heavy snow over EVI were identified. Through further examination of 10 key weather ingredients and pattern recognition analysis, four conceptual models were developed to assist operational meteorologists in recognizing heavy snow patterns and providing more accurate snowfall forecasts for the EVI region.

Each conceptual model was composed of a unique synoptic-scale setting, key weather ingredients and the meteorological mechanisms that lead to heavy snow. A preliminary evaluation was done by using data from 10 snow events that occurred during the winter season from November 2010 to March 2011. Each event was examined in relation to the warning performance, the associated synoptic pattern, key weather ingredients and their contributions to the snowfall. Based on the revealed features, the event was then matched with one of the conceptual models; the key ingredients and the mechanisms contributing to the event were determined. The ingredients and mechanisms were then cross-checked with those depicted in the conceptual model to determine if the model has the capacity to predict the event.

Two events were examined in detail for the evaluation purpose. Preliminary results indicate that these conceptual models have the capacity to provide a reliable guidance about what key processes a meteorologist needs to look for from an approaching weather system and how these processes contribute to snowfall over EVI. In this extent, these conceptual models are considered to be useful in the operation to assist meteorologists to do better forecast and warning decisions.

1E2.6 ID:5645 17:45

Destruction in the 'Prettiest Town in Canada' – An Examination of the Goderich Ontario F3 Tornado

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(Presented by *Stephen Knott*)
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On the afternoon of August 21st, 2011, a tornado formed over Lake Huron associated with an intensifying supercell. It ripped through the centre of historic downtown Goderich with post-storm surveys revealing low-end F3 damage. There were 37 injuries and one fatality.

The tornado was remarkable on a number of counts. First, it occurred in an area where commonly used severe weather forecast parameters suggested only a minimal tornadic risk. In spite of this nominal threat, it caused surprisingly severe damage along a 20 km path, making it the strongest tornado in Ontario in 15 years. Second, the tornado and its parent supercell developed and intensified over the lake, something rarely seen. Third, there have been only two known tornadoes in the Goderich area along the shore of Lake Huron, and both were F0.

This talk will give a brief overview of the storm evolution including storm structure as interrogated using Exeter Doppler radar, which was in close proximity. The synoptic-scale environment and mesoscale factors conducive to supercell development and tornadogenesis will be examined. Although a frontal system had moved through the Goderich area earlier in the day, synoptic-scale forcing improved in the afternoon as the left exit of a strong cyclonic upper jet arrived from Michigan. On the mesoscale, cold pools associated with earlier and ongoing convection combined and led to the development of a strong baroclinic zone, roughly from west to east across Lake Huron, along which the Goderich storm initiated, intensified, and became tornadic.

Using reanalysis data, the synoptic-scale dynamic support will be compared to the upper-level jet structure associated with past F3 (and greater) Canadian tornadoes. We will also discuss the Ontario Storm Prediction Centre's forecasting performance during this event, how the case challenges current conceptual models, and how it may affect future warning decisions.

Coastal Oceanography and Inland Waters PART 2 / Océanographie côtière et eaux intérieures PARTIE 2

Room / Endroit (Symphonie 1), Chair / Président (Jinyu Sheng), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E5.1 ID:5752 INVITED/INVITÉ 16:30

Recent developments in wave modelling with the two-scale approximation implmented in WAVEWATCHIII

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The Two-Scale Approximation (TSA) to the Full Boltzmann Integral (FBI) solution for wave-wave interactions in wind-driven seas decomposes directional spectra into two parts, a broad-scale form (parametric - with a limited number of degrees of freedom) and a superposed local-scale (non-parametric - which retains all of the degrees of freedom in a modeled directional spectrum). Such an approximation utilizes a discrete set of parameter values in the approximation for the broad-scale portion of the spectrum. The question is, how many parameters and how many discrete values of these parameters are needed to provide an accurate approximation for operational purposes? Previously, we considered parameterizations for directional spectra using analyses of observed directional spectra from selected experiments, and found that much of the directionally-integrated characteristics as well as the directional characteristics can be represented well with a small number of dimensions. However, the case when winds are changing, as when a hurricane passes a given location, or when winds rapidly shift direction, as when a front passes a given location, is different. We provide a detailed analysis of turning wind examples, the passage of a front whereby winds blow for 48 hr in one direction and then suddenly turn by 90o for a following 48hr. In these simulations TSA is implemented within WAVEWATCHIIITM (version 3.14, hereafter WW3), and compared to WW3 implementations of DIA (discrete interaction approximation) and WRT (Webb-Resio-Tracy), the full Bolzmann integral; otherwise we use standard source terms for wind input and dissipation (Tolman and Chalikov 1996). In this case, new windsea spectra are generated with dominant directions that differ notably from the old windsea spectra, which then become swell. The standard TSA formulation of Resio and Perrie (2008) fails to accommodate this situation. The problem is that the swell portion of the spectrum dominates the broad-scale term and thus the growing windsea has to be represented by the local-scale, even as it becomes very large. Thus the TSA formulation fails to turn the wave spectrum, until the windsea finally exceeds the swell, leading to a very long lag in the model formulation's ability to turn the wave spectrum in the direction of the new windsea, for example about 36hr, whereas with DIA, or WRT, the waves would turn in ~6hr. To solve this problem, we apply the broad-scale twice, once it is determined that 2 distinct peaks are present in the spectrum, and we judiciously parameterize the high-frequency beta coefficient for each broad-scale term, so as to be consistent to Resio and Perrie (1991), and Long and Resio (2007), which are later developments for the theory behind Phillips' α coefficient. In this manner, we show that TSA can provide accurate simulations, consistent with observations, and with WRT results.

1E5.2 ID:5746 17:00

Modeling the upper ocean response to Hurricane Igor

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The upper ocean response to Hurricane Igor over the Grand Banks was investigated by using a three-dimensional finite-volume coastal ocean model (FVCOM). The model is forced by the atmospheric fields obtained from the NOAA regional reanalysis. The wind and air pressure fields associated with the hurricane were reconstructed using the adjusted Holland hurricane model. The simulated sea level shows high correlation with the observed tide-gauge data at St. John's and Argentia. The model is able to reproduce the peak surges. The model sea surface temperature was validated with buoy data, showing a significant temperature decrease during the hurricane passage.

1E5.3 ID:5614 17:15

Modelling to address aquaculture issues

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Salmon aquaculture has been successfully established in Southern New Brunswick for several years in Passamaquoddy Bay and around Grand Manan Island. The industry is expanding, with more salmon farms being installed or proposed for other Bays in New Brunswick and to Nova Scotia. Regulation of the industry must consider many factors such as carrying capacity, spread of disease between cages and farms and the interaction with the environment including the risks of using therapeutants and the spread of biological waste. It is a challenge to assess these factors because the small scale processes of the cages are influenced by and interacting with the environment of a much larger domain. This presentation will illustrate the approach we are taking to address these problems using unstructured mesh numerical ocean models. These models let us resolve motion in the scale of metres in domains that extend hundreds of kilometers. We will show examples of how the models are used in different applications and describe plans for future studies.

1E5.4 ID:5575 17:30

Dynamics of the Shelfbreak Frontal Circulation near the Sable Gully of Nova Scotia

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The Sable Gully is a broad deep underwater canyon located on the edge of Scotian Shelf to the east of Sable Island. Being the home of many marine species including the endangered Northern Bottlenose whale, the Gully was designated as a Marine Protected Area (MPA) in 2004. Better understanding of physical environmental condition in this MPA is needed for sustainable ecosystem management. Due to the complex topography and highly varying circulation over the Gully, detailed three-dimensional numerical simulations have not been made for this area. In this study, a multi-nested model is used to simulate the three-dimensional circulation in the Gully. The model is driven by tide, wind and surface heat fluxes. The model results are validated by comparing against year-round current observations from four moorings deployed in the Gully from April 2006 to July 2007. The model results show a shelfbreak jet flows from northeast to southwest throughout the year. The circulation in the Gully has a complex vertical structure and varies from season to season. A persistent northward flow occurs in the deep layer of the Gully, indicating the cross shelf transport of deep ocean water onto the shelf.

Low-frequency variability and predictability PART 2 / Variabilité et prévisibilité des oscillations de basse fréquence PARTIE 2

Room / Endroit (Symphonie 2), Chair / Président (Hai Lin), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E6.1 ID:5598 16:30

The New Canadian Seasonal to Interannual Prediction System (CanSIPS)

Bill Merryfield [1], *Juan Sebastian Fontecilla* [2], *Bertrand Denis* [2], *Woosung Lee* [1], *Jacques Hodgson* [2], *Benoit Archambault* [2], *Slava Kharin* [2], *Lewis Poulin* [1], *Louis-Philippe Crevier* [2]
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The Meteorological Service of Canada has its first coupled operational multi-seasonal forecasting system. The Canadian Meteorological Centre (CMC) in collaboration with the Canadian Centre for Climate Modeling

and Analysis (CCCma) has recently implemented a new one-tier climate prediction system which replaced the old two-tier 4 model forecasting system (used before for forecasts of months 1 to 4) and the CCA statistical forecasting system (used in the old system for forecasts of months 4 to 12). The new coupled system combines ensemble forecasts from the CanCM3 and CanCM4 versions of CCCma's coupled global climate model and provide dynamical atmospheric, oceanic and ice predictions for lead times out to 12 months. This system, developed under the second Coupled Historical Forecasting Project (CHFP2) will be described briefly. Forecast skill improvements will be shown. The implementation of this new system allows the issuance of ENSO forecasts, which was not possible before. The predictive skill of NINO3.4 index from this new coupled system will be compared against the skill from other centers.

1E6.2 ID:5733 16:45

Why was the warm Prairie winter of 2011-2012 not forecast?

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The inaugural multi-seasonal forecast of the Canadian Seasonal to Interannual Prediction System (CanSIPS), based on two coupled climate models, was issued by Environment Canada on December 1, 2011. The seasonal forecast for winter (DJF 2011-12) temperatures in western Canada indicated a high probability, ranging from >60% in Manitoba to >90% further west, that seasonal-mean temperature would be below normal, i.e. in the lowest tercile based on 1981-2010 climatology. This reflected the influence of a weak to moderate La Nina that was predicted to intensify slightly in the winter months. Confidence in this forecast, as estimated from historical skill, was relatively high in British Columbia but considerably lower in the Prairie provinces. Seasonal forecasts produced by other centres similarly predicted a colder than normal winter throughout western Canada.

Observed temperatures were in fact far higher than normal during this period in the Prairie provinces, which experienced one of their mildest winters on record. This talk examines reasons for this outcome and for why it was not predicted by CanSIPS or other long range forecast systems. A major role appears to have been played by the Pacific North America (PNA) pattern, which normally tends to be in its negative phase during La Nina winters (historical correlation of DJF-averaged PNA and Nino3.4 indices ~0.47). In DJF 2011-12, however, the PNA was mainly in its positive phase, tending to bring anomalous warmth to the Prairies and northwestern Canada. In addition, the Arctic Oscillation (AO) and especially the North Atlantic Oscillation (NAO) were in strongly positive phases during most of the winter, and although their influence on Prairie winter temperatures is less distinct than that of the PNA, such conditions have historically tended to bring anomalous warmth particularly to the southeastern Prairies. The difference between forecast and observed Prairie winter temperatures thus appears to be caused by some combination of these influences, all of which are concentrated in the Prairies as compared to neighboring Canadian regions and are poorly predictable on seasonal time scales. Such considerations may explain the low seasonal predictability of Prairie winter temperatures in general.

1E6.3 ID:5680 17:00

Interannual Variability and the Climate Change Signal for the 2m Temperature in the NARCCAP Regional Climate Projection Ensemble.

Sebastien Biner , *Ramon De Elia*
Ouranos
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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 database of climate simulations over a region covering most of North America at the regional scale. These simulations are produced with six Regional Climate Models (RCMs) using different sources of large-scale information in recent and future climate.

Results of the analysis of the 2m Temperature interannual variability from the NARCCAP ensemble are presented. The analysis covers RCM simulations using reanalysis as well as General Circulation Models (GCMs) as driving data. These results are then used as a yardstick to look at the climate change projections and evaluate their strength in a signal to noise paradigm.

1E6.4 ID:5358 17:15

Potential predictability of Northern America Surface Temperature -- Information-based predictability measure vs Signal-to-Noise ratio.

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In this study, the potential predictability of the northern America (NA) surface air temperature was explored using information-based predictability framework and ENSEMBLE multiple model ensembles. The emphasis was put on the comparison between information-based and conventional SNR (signal-to noise ratio)-based potential predictability, and the optimal decomposition of predictable component using the method of maximizing the predictable information (or equivalent the maximum of SNR).

It was found that the conventional SNR-based measure underestimates the potential predictability, in particular in these areas where the predictable signals are relatively weak. The most predictable components of the NA surface air temperature can be characterized by the interannual variability mode and the long term trend mode. The former is inherent to the tropical Pacific sea surface temperature (SST) forcing such as ENSO (El Nino and Southern Oscillation) whereas the latter is closely associated with the global warming. The amplitude of the two modes has geographical variations in different seasons. Furthermore, the possible physical mechanisms responsible for the two most predictable modes and the potential benefits for the improvement of actual prediction skill were discussed.

1E6.5 ID:5322 17:30

On the volatility of Southern Oscillation Index

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This study aims to test and model the volatility or dynamic variance of the Southern Oscillation Index (SOI) during 1940-2011 in order to show the variability and change in the second order moment of SOI using the ARMA-GARCH error model. The nonparametric tests show a significant change in the mean, variance and distribution function of SOI before and after 1976. Although the ARCH effect is not observed in the residuals of an ARMA(1,1) model for SOI time series before 1976, the ARCH effect is significant in the residuals of an ARMA(1,1) model for SOI time series for 1976-2011 period and an ARMA(1,1)-GARCH(3,0) models are fitted to SOI time series after 1976. The stationary test shows that both SOI time series are stationary. However, the stationary is becoming weaker after 1976. The nonlinearity test also indicates increasing nonlinearity after 1976. These results show that the volatility of SOI is becoming more dynamic and short–

run persistence of SOI is becoming stronger, more variable and less stationary in the recent decades. Therefore, the contribution of this reduction in stationarity and increase in variability and volatility to the global climate change and variability is becoming stronger and more important.

1E6.6 ID:5379 17:45

Tropical/Extratropical forcing on wintertime variability of the extratropical temperature and circulation

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The secular trends and interannual variability of wintertime temperatures over northern extratropical lands and circulations over the northern hemisphere are examined using the NCEP/NCAR reanalysis from 1961-2010. A primitive equation dry atmospheric model, driven by time-averaged forcing in each winter diagnosed from the NCEP reanalysis, is then employed to investigate the influences of tropical and extratropical forcing on the temperature and circulation variability. The dynamic and thermodynamic maintenances of the circulation and temperature anomalies are also diagnosed. Distinct surface temperature trends over 1961-1990 and 1991-2010 are found over most of the extratropical lands. The trend is stronger in the last two decades than that before 1990, particularly over eastern Canadian Arctic, Greenland, and Asia. The exchange of midlatitude and polar air supports the temperature trends. Both extratropical and tropical forcings contribute to the temperature and circulation trends over 1961-1990, while extratropical forcing dominates tropical forcing for the trends over 1991-2010. The contribution of the tropical forcing to the trends is sensitive to the period considered. The temperature and circulation responses to the tropical and extratropical forcings are approximately additive and partially offsetting. Covariances between the interannual surface temperature and 500-hPa geopotential anomalies for the NCEP reanalysis from 1961-2010 are dominated by two leading modes associated with the North Atlantic Oscillation (NAO) and Pacific-North American (PNA) teleconnection patterns. The extratropical forcing accounts for a significant part of the NAO and PNA associated variability, including the interannual variability of stationary wave anomalies, as well as dynamically and thermodynamically synoptic eddy feedbacks over the North Atlantic and North Pacific. The tropical forcing contributes to the PNA related temperature and circulation variability, but has a small contribution to the NAO associated variability. Additionally, relative contributions of tropical Indian and Pacific forcings are also assessed.

AUTHORS' WORKSHOP / ATELIER POUR LES AUTEURS

Room / Endroit (Symphonie 4), Chair / Président (Richard J.M. Asselin), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E7.1 ID:6175 16:30

Authors' Workshop / Atelier pour les auteurs

Sheila Bourque [1], *Guoqi Han* [1], *William Hsieh* [1], *Douw Steyn* [1], *Richard Asselin* [2], *Victoria Gardner* [3]

(Presented by *Richard Asselin*)

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Are you a new to research? If so, this workshop is for you! This informal, interactive session will show you how to prepare a paper for publication, how to select the appropriate journal and how to publicize your work. Topics will include structure and logic of a scientific paper, selection of a title, form and function of the abstract, selection of keywords, preparation of tables and graphics, choice of symbols, references, common mistakes and submission of the manuscript. You will learn about the factors of journal quality, how to interact with editors, the peer refereeing system, revision of manuscripts, copyright issues and tools available to authors. You will have the opportunity to ask questions and receive advice from Atmosphere-Ocean's friendly editors after a presentation.

The workshop is mainly, but not exclusively, for new authors. Language will be English but questions can be answered in French.

Êtes-vous un nouveau chercheur ? Dans ce cas, cet atelier s'adresse à vous ! Cette présentation informelle et interactive vous apprendra comment préparer un article pour publication, comment choisir la revue appropriée, comment publiciser votre travail. Les sujets couverts incluent la structure et l'ordre d'un article, le choix du titre, la forme et la fonction du résumé, les mots-clés, la préparation des tableaux et graphiques, le choix des symboles, les citations, les fautes courantes et la soumission du manuscrit. On parlera des facteurs de qualité des revues, comment interagir avec les éditeurs, le système de relecture par les pairs, la révision des manuscrits, les droits d'auteur, les outils disponibles pour les auteurs. Vous aurez l'occasion de poser des questions et de recevoir des conseils de la part des éditeurs affables d'Amosphere-Ocean après la présentation.

L'atelier est conçu spécialement mais pas exclusivement pour les nouveaux auteurs. La présentation sera en anglais mais les réponses aux questions peuvent être en français.

General NWP-WAF PART 2 / NWP WAF en général PARTIE 2

Room / Endroit (Ovation), Chair / Président (R Bruce Telfeyan), Date (29/05/2012), Time / Heure (16:30 - 18:00)

1E3.1 ID:5621 16:30

Bridging the valley of death: Defining a process for transitioning promising new mesoscale innovations from research to operations

Jamie Wolff [1], *Louisa Nance* [1], *Brad Ferrier* [2], *Clifford Mass* [3], *Barbara Brown* [4], *Ying-Hwa Kuo* [5]
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A key aspect for the Developmental Testbed Center (DTC) to facilitate the transition of new science innovations from research to operations (R2O) is to provide access to and support for components of state-of-the-art numerical weather prediction systems to the research community. With the contribution of new innovations back to the code base by the user community, a crucial aspect of the DTC mission can be exercised: extensive testing and evaluation of promising codes emerging from the research community can be performed in a common framework to demonstrate the potential of new science and technologies for use in operations. The ultimate goal of these specific activities is to accelerate the rate at which new technology is infused into operational weather forecasting. For codes to progress from the research to operational realm, several stages of testing must occur. In an effort to streamline the R2O process, the DTC has laid out a testing protocol to engage the research community in the steps necessary for preparing and nominating mesoscale modeling code deemed ready for extensive DTC testing and evaluation in an operationally similar environment. Briefly, the first stage of testing will be conducted by the researchers on high-impact or field program case studies. In an effort to provide a common framework for researchers to demonstrate the merits of new developments, the DTC is establishing the Mesoscale Model Evaluation Testbed (MMET), which will provide initialization and observation data sets that can be used by the entire user community for testing and evaluation at this initial stage. The DTC will utilize the same data sets from the MMET to provide baseline results to the research community for specific operational configurations. If improved forecast accuracy is shown during the first stage of testing using reasonable compute resources, the innovation may be recommended to continue on to the second stage of testing. The second stage of testing will be conducted by the DTC and would be more extensive in nature and potentially include data assimilation cycling depending on the target application. Along with sharing the extensive test results with the user community, information will be shared with interested operational entities. The ultimate decision to proceed to the pre-implementation testing phase would be based on a variety of factors, including forecast performance and computational resource requirements.

The DTC R2O testing protocol, along with the MMET, will be described in detail in this presentation.

1E3.2 ID:5345 16:45

Initial Experiments on Simulation of Windshear and Significant Convection Events Using the Aviation Model

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Development is underway at the Hong Kong Observatory (HKO) to implement a new high-resolution numerical weather prediction (NWP) system called Aviation Model (AVM) to support very-short-range forecast and aviation weather services at the Hong Kong International Airport (HKIA). AVM is developed on the basis of the Weather Research and Forecasting Model (WRF-ARW) with target horizontal resolutions of 600 m and 200 m over the Pearl River Estuary and provide model forecasts up to 9 hours ahead. In this paper, results of initial experiments using AVM will be presented to demonstrate model capabilities in simulation of significant convection, as well as windshear events due to sea-breeze and terrain. For windshear cases, the simulated wind profiles along flight paths are in generally good agreement with the headwind change as observed from actual flight data. Moreover, model sensitivity in predicting sea-breeze circulation at HKIA under different parameterization of near-surface and boundary layer processes will be

discussed.

1E3.3 ID:5431 17:00

Description and evaluation of two dynamic initialization schemes for the Naval Research Laboratory's tropical cyclone prediction model

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Accurate initialization of tropical cyclones (TCs) in numerical prediction systems is critical for the subsequent intensity and structure prediction. In this study, we develop two dynamic initialization schemes that can be used in TC numerical prediction systems. The first scheme, identified as the TC dynamic initialization (TCDI) package, includes two major components. The first part is the removal of the TC vortex in the initial field of the TC forecast system. The second part is a dynamic initialization of the TC vortex spun up offline with a full nonlinear dynamics and physics in a quiescent environment. During the spin-up period, the TC vortex is forced toward either the best track estimated central minimum pressure or the wind structure. The dynamic and thermodynamic balanced TC vortex generated by the spin-up process is then added back to the initial field of the forecast system. Note that the model used for offline spin up does not have to be the same model as the TC forecast system. The second approach, identified as the dynamic initialization (DI) scheme, involves a forward relaxation period of 12 hour when the entire three-dimensional fields are nudged to the initial winds prior to the start of model integration. Both schemes are tested on multiple TCs from 2009-2011 using the Navy's Coupled Ocean/Atmosphere Mesoscale Prediction System – Tropical Cyclones (COAMPS-TC). The track and intensity prediction evaluation of each scheme with the control 3DVAR initialization is presented.

1E3.4 ID:5583 17:15

MSC and COMET: Collaborative Training in Arctic and Satellite Meteorology and Winter Weather

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The COMET Program has been engaged in several training initiatives of interest to Meteorological Service of Canada (MSC) forecasters over the past year. In that time, we developed three interactive, web-based, distance learning modules on topics ranging from Arctic meteorology and oceanography to satellite feature identification of atmospheric rivers and cyclogenesis. The Arctic Meteorology and Oceanography module was motivated by the fact that diminishing sea ice has opened the Arctic to expanding navigation and operations. Forecasters are increasingly predicting weather in support of those operations. This module, which was a collaborative effort with MSC and the U.S. Navy, provides forecasters with a brief introduction to the Arctic, including its geography, climatology, and the forecast problems they are likely to encounter. The module follows a U.S. Coast Guard Cutter on a voyage from Dutch Harbor, in the Aleutian Islands, to Barrow, on the north coast of Alaska. Various topics are addressed along the way in a series of short, stand-alone lessons.

The Dynamic Feature Identification: The Satellite Palette series added two new modules: Atmospheric Rivers and Cyclogenesis. The first module presents the global moisture transport phenomenon known as the Atmospheric River (AR). ARs are responsible for transporting the majority of maritime moisture from low to middle latitudes. Advanced satellite products, including Integrated Water Vapor and Total Precipitable Water, provide excellent observations of AR development and evolution. This module demonstrates the usefulness of these products in forecasting the impacts of ARs, especially when they are combined with numerical weather prediction products. Several AR case studies highlight the importance of using satellite information regarding ARs and allow the user to practice forecasting their impacts.

The Cyclogenesis module provides a basic description of patterns in satellite imagery associated with the birth of cyclones in mid-latitudes. Using 6.7 µm water vapor (WV) imagery the module builds a conceptual model of cyclone development characterized by an existing frontal zone, an upstream perturbation in the flow, and an emerging cloud shield. Several case studies using animated satellite imagery help refine the conceptual model based on the relationship between the upstream perturbation and the downstream frontal band. Forecast implications of various scenarios are also discussed.

In addition, COMET hosted the MSC/COMET Winter Weather Course 17-28 October 2011 at its residence classroom facility in Boulder, Colorado. For over a decade, this course has been a cornerstone of the MSC/COMET training partnership, aimed at strengthening the links between the atmospheric research and operational weather forecasting community. Participants included forecasters from MSC, the Defence Weather Services, U.S. Navy, National Weather Service and Europe , and provided an excellent opportunity for exchange among operational forecasters from around the world. Instructors included university professors and operational experts from MSC and NWS. The course focused on high impact synoptic and mesoscale weather systems, with the goal of increasing the participants' understanding of atmospheric processes and their application to winter forecast operations. Conceptual lectures were complemented by hands-on, case-based laboratory exercises. Lectures incorporated enhanced instructional techniques, including a new method for using interactive polling during lectures, as well as daily application sessions built around lecture topics learners found interesting or difficult to understand.

This Project was undertaken with the financial support of the Government of Canada provided through the Department of the Environment. The views expressed herein are solely those of the University Corporation for Atmospheric Research.

Ce Projet e été realize avec l'appui financier du Gouvernement du Canada agissant par l'entremise du Ministère de l'Environnement. Let opinions exprimées dans ce document sont celles de University Corporation for Atmospheric Research.

1E3.5 ID:5640 17:30

UMOS-MIST Forecasts of Dew-Point Temperatures Using the Canadian RDPS

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At the Canadian Meteorological Centre (CMC), humidex site forecasts are currently calculated using dry-bulb temperatures and dew-point spreads interpolated from numerical models, either the Regional or Global Deterministic Prediction System (respectively RDPS and GDPS) depending on the time of validity.

Dew-point spreads from those models present important biases and errors, therefore statistical forecast models using CMC Updatable Model Output Statistics (UMOS) system were developed for each site with valid dew-point temperature observations. Same as the currently operational UMOS dry-bulb temperature predictand, Multiple Linear Regression was applied on a 2-year sample stratified seasonally and 3-hourly. A reduction of variance criterion was used for predictors' selection. UMOS dry-bulb and dew-point temperature forecast models were developed independently; therefore a coherence scheme was developed to resolve cases where UMOS dew-point temperature exceeded dry-bulb temperature.

For dissemination purposes, public weather forecasting requires forecasts of dry-bulb and dew-point temperatures at sites where no observations are available. In the past, a weighted average of the sums-of-square-and-cross-products (SSCP) matrices of nearby stations was used to produce a synthetic SSCP matrix representing a site without observations (hereafter called synthetic site). For other sites not included in the processes discussed above, further interpolation was done using kriging and the average of all UMOS forecasts as a trial field.

In order to improve forecast performance and simplify maintenance, the synthetic matrix approach was dropped and the old kriging software was replaced by MIST (Moteur d'Interpolation STatistique), an optimum interpolation procedure already used in the Canadian Precipitation Analysis (CaPA) system. Among other advantages, MIST has the capacity to use the GEM-Regional outputs as trial fields and includes a leave-one-out cross-validation (LOOCV) procedure.

Verification results of UMOS and RDPS dew-point temperature forecasts using an independent 1-year sample will be presented showing that UMOS brings significant improvements in terms of bias and error. In addition, results from the MIST LOOCV procedure will be presented to demonstrate the MIST procedure's legitimacy.

1E3.6 ID:5637 17:45

Cloud ceiling analysis in the RTMA

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As one of the important elements for aviation weather, the cloud ceiling analysis is the latest addition to the Real-Time Mesoscale Analysis (RTMA) system. With the 2D surface analysis system, two approaches may be considered to proceed with the ceiling analysis. One can either choose to analyze ceiling directly as a 2D parameter, or diagnose the ceiling field from the analyses of total cloud amount and cloud base. The latter approach is adopted in this study. The variational analyses of the total cloud amount and the cloud base height of the lowest cloud seen everywhere are performed first, then the ceiling is created by masking out those points in the cloud base height field where the analyzed cloud amount is less than 50%.

The downscaled 1-hour Rapid Refresh forecasts are used as the first guesses, and the cloud information from METAR, various surface automated weather stations, and GOES cloud product is utilized in this study. Effort is also spent on missing data filling and quality control using the combined observation information such as total cloud amount, base height of the lowest cloud, and weather information, as well as cloud amounts and base heights at different levels. Preliminary tests are conducted for the analyses of the total cloud amount and the cloud base height of the lowest cloud, and the results will be presented at the conference.

Plenary Day 2 / Plénière jour 2

Room / Endroit (Grand salon), Chair / Président (R Bruce Telfeyan), Date (30/05/2012), Time / Heure (08:30 - 10:00)

P2.1 ID:5360 INVITED/INVITÉ 08:30

Tropical cyclones, low-level jets, and thermodynamic climate change

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A robust aspect of dynamical climate projections, consistent with thermodynamic theory, is an increase in lower-tropospheric water vapor content. What are the dynamical consequences of such a thermodynamic change for the frequency and severity of extreme weather accompanying synoptic and mesoscale systems? General Circulation Models (GCMs), while essential to decadal and longer climate projection, are too coarse in resolution to study moist mesoscale dynamics. Regional climate models (RCMs) are able to represent synoptic and some mesoscale phenomena, but RCM integrations typically still require the parameterization of convection. Increased vapor content is accompanied by the potential for enhanced condensational heating, which may in turn alter cyclonic weather systems significantly; analysis of these changes requires very high resolution (~6 km grid length or less). High resolution numerical simulations are used here to illustrate how changes in the thermodynamic environment affect tropical and midlatitude cyclones.

Condensational heating carries the strongest dynamical influence in regions of large pre-existing potential vorticity (PV), introducing the possibility of feedbacks for cyclonic systems. Dynamical mechanisms acting in tropical cyclones (TC) respond to expected thermodynamic changes, affecting both maximum TC intensity and TC frequency. High resolution model experiments based on projected thermodynamic changes clarify the mechanism leading to increases in the intensity of the strongest tropical cyclones, and also confirm the mechanisms responsible for decreased future TC frequency.

In extratropical cyclones, the diabatic contribution to the cyclonic circulation has been shown to be 50% or more in past studies, and latent heat release contributes to the strength of the low-level jet (LLJ) often found immediately ahead of cold fronts at the western boundary of the cyclonic warm sector. With projections of increased future precipitation due to enhanced vapor content, we investigate the dynamical consequences of potentially heavier cold-frontal precipitation. We hypothesize that heavier rainfall leads to increased diabatic PV generation and a stronger LLJ, which in turn increases poleward moisture transport. Using the “pseudo global warming” approach, we examine two major LLJ events, and explain varying responses to thermodynamic warming between the events.

P2.2 ID:5291 INVITED/INVITÉ 09:15

Assessing the economic impacts of weather and value of weather forecasts

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Understanding the socio-economic impacts of weather provides a basis for prioritizing actions to mitigate and respond to weather events and understanding the value of improvements in weather forecasts. In this talk we discuss four different topics in the economics of weather and weather forecasts: (1) the economic impacts of weather, (2) the value of current forecasts, (3) the value of improved forecasts, and (4) the value

of research to improve forecasts. In each topic area we present one or more applications of empirical research, discuss the theoretical and conceptual basis of the methods and results, and the potential use of information from such research in policy and decision making. We briefly present results from other studies illustrating a range of applications of economics to weather impacts and weather forecasting as well as interdisciplinary ties to related social sciences such as communication and psychology. While the primary focus is weather related we note that the methods and applications can be extended to issues in the water and climate arenas as well.

Coastal Oceanography and Inland Waters PART 3 / Océanographie côtière et eaux intérieures PARTIE 3

Room / Endroit (Symphonie 1), Chair / Président (Guoqi Han), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B5.1 ID:5817 10:30

Diagnostics of wind reanalyses and GCM-RCM results at 10 m above sea level in Eastern Canada.

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Recently, Ouranos was involved in several projects of the Ministry of Transport of Quebec aiming to assess the vulnerability of coastal infrastructures to storm surges and extreme waves in the Nunavik and the Gulf of St-Lawrence. These projects were based on oceanographic numerical models of storm surges and wave climate forced with reanalysis data and GCM and RCM data. A key variable of these models was the wind vector at 10 m above the sea surface. A subproject was designed to assess the reliability of wind data from various models. Since winds above the sea were used, two marine meteorological stations (Sable Island and Magdalen Islands) were chosen to compare observed wind with model data. These stations are both locate within 10 to 15 m above sea level and the topography around the station is low, minimizing the interaction of local topographic features with the wind flow. The correlation between NARR data and observations for a 30 years-period (3h time interval) is good with R= 0,94 and 0,91 respectively. By comparison, correlations between coastal stations with similar characteristics at Kuujjuarapik and Miscou Island are in the range of 0,79 and 0,76, The slope of the regression curve is close to 1,00 for NARR data. However, NCEP2 data, for the same period, gives lower correlation and a slope systematically 20% to 30% higher than 1. When comparing NCEP2, NCEP and NARR data at higher altitude (1000, 950 and 850 HPa), the correlation and slope improve radically, suggesting that the discrepancy observed at 10 m is link to the boundary layer profile computation of the models. Other statistics of the model wind were also computed to compare some GCM and RCM results (wind roses, extreme values) in order to assess the uncertainty of results. Comparison of statistics at 10 m and at higher altitude was used to assess the reliability of climate model to predict future wind pattern above the sea.

2B5.2 ID:5472 10:45

Application of a coupled ocean-ice model for simulating circulation, hydrography and sea-ice conditions in the Gulf of St. Lawrence and Scotian Shelf

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A coupled ocean-ice numerical model based on the NEMO modelling system is applied to the Gulf of St. Lawrence and the Scotian Shelf. The model uses version 9 of the Océan Parallélisé System (NEMO-OPA9) as the ocean circulation component, and version 2 of the Louvain-la-Neuve Ice Model (NEMO-LIM2) as the sea-ice component. The coupled ocean-ice model has two components with different horizontal resolutions. Both components are forced by the atmospheric reanalysis fields produced by Large and Yeager (2004). An outer component of the outer model has horizontal resolution of ~1/4º for the northwest Atlantic Ocean between 32ºW and 81ºW and between 33ºN and 57ºN and is also forced at the lateral open boundaries by ocean reanalysis data produced by Smith et al. (2010). The inner component of the coupled model has a horizontal resolution of ~1/12º for the Gulf of St. Lawrence and the Scotian Shelf and is forced by monthly river runoff based on the estimates of freshwater discharge of Dai and Trenberth (2002). The two-way nesting technique is used for the interaction between the two components. In this study the performance of the coupled model is assessed and model results are used to investigate the physical processes affecting the circulation, hydrography and ice conditions at different time-scales over the Gulf of St. Lawrence and the Scotian Shelf.

2B5.3 ID:5295 11:00

Modelling Inter-annual and Intra-seasonal Water Property Variations and their Impact on Sea Lice in the Broughton Archipelago

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A high resolution circulation model for the Broughton Archipelago, British Columbia is used to simulate the time-varying, three-dimensional velocity, temperature, and salinity fields required by a companion biological model that simulates the transport and development/mortality of sea lice emanating from salmon farms in the region. Hindcasts are carried out for May and May 2008, and May 2010, times of the year when changes in river discharge, solar radiation, and air temperature impact near-surface salinities and temperatures and thus, lice development and survival. Model values are compared with available observations and estimated differences in the resultant lice concentrations are discussed.

2B5.4 ID:5334 11:15

On boundary mixing mechanisms in the Lower St. Lawrence Estuary

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In a previous study, we showed that mixing at boundaries plays a significant but not dominant role in the mixing budget of the Lower St. Lawrence Estuary (LSLE). We now attempt to identify mixing mechanisms that are at work at the northern sloping boundary of the LSLE, using a high resolution mooring deployed in fall 2011 and about 1000 casts taken between 2010 and 2011 with a vertical microstructures profiler (VMP500). Preliminary results show that both the semi-diurnal (M2) and the fortnightly tide cycles have an incidence on the modulation of turbulence at this boundary. Dissipation rates of turbulent kinetic energy and high frequency internal waves activity are maximum at about ~2h before high tide, a period corresponding

to an upslope flow at the sampling site. Episodic shear intensification periods also appear in the bottom boundary layer during low tide. Observations also suggest that dissipation rates in spring tide are twice as high as during neap tide.

2B5.5 ID:5441 11:30

Estimating the density of lake waters - is there an easy way?

Rich Pawlowicz
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Investigations of lake dynamics, either by modelling or by analysis of observations, require estimates of the water salinity and density, and/or an equation of state relating the two. Although temperature effects are often the largest contributor to density variations, the effects of dissolved material can also be important. However, there is currently no easy method of quantifying either the amount, or the effect of this dissolved material with any degree of certainty.

Here I present simple rules that allow one to modify algorithms that are part of the Thermodynamic Equation of Seawater 2010 to determine salinity and density in lake waters with reasonable accuracy. These rules require classifying a particular lake into one of several types, depending on its dominant chemical composition. Examples are given.

2B5.6 ID:5554 11:45

Simulating the effects of phosphorus limitation in the Mississippi and Atchafalaya river plumes

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The Texas-Louisiana shelf receives high nutrient loads from the Mississippi-Atchafalaya river system during spring. It supports high primary production, which contributes to the development of hypoxia in summer. While phytoplankton growth is typically nitrogen limited in the coastal ocean, recent observations have provided strong evidence for phosphorus limitation in the Mississippi River plume between May and July at the peak of nitrate discharge. Here, we investigate the occurrence, distribution and effects of this limitation using a circulation model of the northern Gulf of Mexico coupled to a multi-nutrient biological model. Results from the 7-years simulation (2001-2007) demonstrate recurrent phosphorus limitation between the Mississippi and Atchafalaya deltas in July. Anomalies in the rate of primary production and fluxes of particulate organic matter reveal a time-delay and a shift westward from the Mississippi delta due to phosphorus limitation. Discharge scenarios with altered phosphate concentrations (±50%) indicate a 40% variation of the phosphorus-limited area in July, which illustrates the sensitivity of the system to nutrient management practices. The effect on bottom oxygen concentrations and the link with hypoxia is evaluated.

Climate Data Homogenization and Trend Analysis

PART 1 / Homogénéisation des données climatologiques et analyse de tendances PARTIE 1

Room / Endroit (Symphonie 2), Chair / Président (Lucie Vincent), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B7.1 ID:5567 10:30

Sources of Non-Climatic Biases in Temperature Data Related to Automation and the Impact on Climate Trends in Oklahoma

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For over 100 years, the Cooperative Observer Network (COOP) of the National Oceanic and Atmospheric Administration has monitored the United States climate. The COOP relies primarily on human volunteers to manually record daily air temperature and precipitation observations. In the past decade, the National Weather Service has taken initial steps to modernize the COOP network by upgrading a limited number of sites to automated weather stations. It is obvious that the increased temporal resolution and real-time availability of automated weather observations will provide significant new benefits, but many scientists wonder how this transition will affect the quality of the climate record.

To investigate the effect of automation on the temperature record, a large sample of Oklahoma COOP data was compared with nearly collocated automated data from the Oklahoma Mesonet. A number of discrepancies were discovered. Automated data from the United States Climate Reference Network were also used to help explain the discrepancies. Although significant biases were evident in the daily data, the longer-term data (e.g., monthly and annual averages) had little bias, especially if the COOP data used were adjusted via methods employed at the National Climatic Data Center.

2B7.2 ID:5588 10:45

Discontinuities in reanalysis datasets and an ongoing homogenization effort on NASA MERRA

Junye Chen [1], *Mike Bosilovich* [2], *Eugenia Kalnay* [3], *Franklin Robertson* [4], *Yan Zhou* [3]
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By assimilating historical observation with NWP model output, reanalysis datasets provide long-term comprehensive description of the history of the climate system in recent decades. They are the base of a large amount of current knowledge about the climate trend. On the other hand, discontinuities in time series commonly show in reanalysis datasets due to changes in observing system and biases of model. In this presentation, first we will discuss about the discontinuities in previous reanalysis datasets and the associated uncertainties in climate change trend study. Then we will present the conception and some preliminary results of an ongoing effort to homogenize the NASA MERRA reanalysis dataset. The

homogenization strategy includes systematic assessment of the impacts of observing system changes in reanalysis and utilization of the impact information to construct patches to adjust the reanalysis data in earlier period to match with the data in later period when a change in observing system causes discontinuity in the reanalysis time series. The homogenization result is encouraging, even based on simple direct offset method. More sophisticated methods will also be discussed.

2B7.3 ID:5323 11:00

Water Vapour Pressure & Temperature Trends in North America during 1948-2010

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Over 1/4 billion hourly values of temperature and relative humidity observed at 309 stations located across North America during 1948-2010 were studied. The water vapour pressure was determined and seasonal averages were computed. Data were examined for possible inhomogeneities arising from changes in instruments and/or procedure before trends were found. Statistically significant warming trends affecting the midwestern U.S., Canadian prairies and the western Arctic are evident in winter and to a lesser extent in spring while statistically significant increases in water vapour pressure occur primarily in summer for some stations in the eastern half of the U.S.

2B7.4 ID:5545 11:15

Homogénéisation des températures du Québec méridional, 1960 2008

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Dans le contexte de changements climatiques, et suite à l’observation d’une augmentation des gaz à effet de serre, la surveillance de l’évolution des températures devient un enjeu stratégique à saveur socio-économique et environnementale de première importance. La tendance des températures annuelles moyennes est d’ailleurs un indicateur de développement durable depuis 2009.

En 2005, un travail d’homogénéisation des données de température a été réalisé par le Service de l’information sur le milieu atmosphérique (SIMAT) pour 52 stations du Québec méridional afin de mesurer l’évolution des températures sur la période 1960 2003. Une nouvelle base de données, couvrant la période 1960 2008, vient d’être développée dans le but de mettre à jour l’évolution des tendances des températures du Québec méridional. Afin d’améliorer la couverture régionale, le SIMAT a procédé à l’homogénéisation des séries de températures pour 55 stations, majoritairement opérées par des observateurs, ce qui permet de réduire les biais qui résultent parfois de l’automatisation de la cueillette de données.

Pour contourner le problème des valeurs manquantes, une estimation de ces valeurs a été calculée à partir des stations voisines. Ces estimations ont permis d’augmenter considérablement le nombre de mois et d’années pouvant être utilisés pour la surveillance de l’évolution du climat et de ses tendances. Les données des températures sont ensuite ajustées pour chacune des 55 stations en se référant à au moins trois stations voisines. La consultation des métadonnées, lesquelles ont récemment été numérisées, permet de justifier la présence d’un saut. L’homogénéisation des séries de températures est réalisée aux échelles annuelle, saisonnière, mensuelle et quotidienne. Pour réaliser cette étude d’homogénéisation, les séries temporelles de 140 stations ont été nécessaires.

Il est donc maintenant possible de calculer la tendance des températures maximale, minimale et moyenne,

tout comme d'analyser le comportement de quelques indicateurs climatiques.

2B7.5 ID:5349 11:30

Recent developments on the homogenization of surface air temperature in Canada

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A second generation of homogenized temperature dataset has been prepared for climate trend analysis. Monthly means of daily maximum and minimum temperatures (tmax and tmin) were examined at 338 locations. Data from co-located observing sites were sometimes merged together to create time series that are longer, hence making them more suitable for trend analysis. At some locations, data were adjusted to account for artificial discontinuities. Two types of adjustments were applied to the temperature series. The first type of adjustments was due to the nation-wide change in observing time in July 1961: it was applied to the daily minimum temperatures of 120 synoptic stations. The second type of adjustments was resulting from homogeneity testing. Two techniques were used to detect non-climatic shifts in de-seasonalized tmax and tmin time series. The first technique was based on multiple linear regressions (MLR) and the second on the penalized maximal t test (PMT). Monthly adjustments were derived from a recently-developed Quantile-Matching (QM) algorithm so that the empirical distribution of the monthly mean temperature, before and after each shift, matches each other. The monthly adjustments were applied to resolve the shifts detected at 116 locations for tmax and 123 locations for tmin. Annual and seasonal temperature trends based on this new homogenized temperature dataset were analyzed for Canada for 1950-2010 and Southern Canada for 1900-2010. During the presentation, the latest methodologies will be describing as well as the updated temperature trends to 2010.

Regional Climate Modelling and Climate Projections PART 1 / Modélisation du climat régional et projections du climat PARTIE 1

Room / Endroit (Symphonie 3), Chair / Président (J.P.R. Laprise), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B6.1 ID:5783 INVITED/INVITÉ 10:30

Dynamical downscaling for regional climate modelling: how should we nudge?

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Climate varies across a wide range of temporal and spatial scales. Yet climate modelling has long been approached using global general circulation models (GCM) that can resolve only the broader scales of atmospheric circulations. Clearly, large-scale climate determines the environment for mesoscale and microscale processes that govern the weather and local climate.

There is thus a need to develop downscaling tools to generate finer-scale projections of local climatologies. In this context, dynamical downscaling consists of driving a regional climate model (RCM) by a GCM. However, long-term RCM modelling with continuous runs can display fairly low performance since the "initial condition memory" disappears with time. One way to overcome this problem is to use nudging technique. This technique consists of partially imposing the large scale of the driving fields on the RCM simulation with the aim of disallowing large and unrealistic departures between driving and driven fields. Two different types of nudging exist: spectral nudging which consists of driving the RCM on selected spatial scales and indiscriminate nudging which consists of relaxing the RCM's prognostic variables towards the GCM values within a predetermined relaxation time. The two techniques require constant adjustments.

The objective of this work is to gain a general insight into the key mechanisms involved in the impact of nudging on the large scales and the small scales of a regional climate simulation. A 'Big Brother' (BB) experimental approach is used where the true atmospheric state is known, unlike when RCMs are used in practice. This work addresses the question with (i) a quasi-geostrophic model and (ii) the WRF model. We investigate the link between nudging and atmospheric predictability, numerical domain size, model resolution, and boundary conditions time interval. Finally, the question of the choice of the variables to be nudged for optimal simulations is addressed.

2B6.2 ID:5338 11:00

The use of the spectral nudging technique in studies of RCM sensitivity to parameter modifications

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Sensitive dependence of Regional Climate Model (RCM) simulations to arbitrary small modifications, such as perturbations in the initial conditions, often represents a nuisance in RCM testing and development. When assessing the impact of RCM modification on the simulated climate, the issue the researcher faces is the detection of the model response to modification (signal) among the quasi-random noise originating from the sensitive dependence. In this presentation, we will discuss the possibility to use the large-scale spectral nudging technique in studies of RCM response to modification, in order to reduce the noise of sensitive dependence. For this purpose, the response of the fifth-generation Canadian RCM (CRCM5) simulations to a modification of a deep-convection parameter in a spectrally nudged simulation setup will be compared to the response in an identical setup with spectral nudging turned off. The first- and second-order statistics of model response will be decomposed into: (1) the signal due to parameter modification per se and (2) the noise originating from the sensitive dependence. The results show that the spectral nudging efficiently reduced the noise while still returning signal patterns largely representative of the no-nudging configuration, which gives support to the use of spectral nudging in RCM sensitivity studies. However, potential alterations of the signal by the spectral nudging are found in the time-mean model response.

2B6.3 ID:5304 11:15

The impact of the nesting-field errors on the large scales simulated by the Canadian Regional Climate Model version 5 for large domains of integration

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Several studies have shown that the Regional Climate Models (RCMs) are able to reproduce well the large- and small-scale climate statistics when nested with perfect lateral boundary conditions. However, in most applications, the RCM lateral boundary conditions are provided by General Circulation Model (GCM) simulations or reanalysis, which are not perfect. Therefore, the nesting fields have errors and these errors have an impact on the RCM simulations.

The estimation of the RCM errors arising from errors in lateral boundary conditions represents an important issue in RCM studies and constitutes the main objective of this presentation. We question whether the high resolution of the Canadian RCM can improve the statistics of the large scales of the driving model, when the RCM is run over very large domains. The study is developed in the “Imperfect Big-Brother” framework, using the full version designed for RCM nested with global simulations, and uses four increasingly larger RCM domains of integration. In this presentation we show results obtained for wintertime statistics over the North American continent.

2B6.4 ID:5590 11:30

Systematic calibration of regional climate models and implications for expert tuning

Omar Bellprat , *Sven Kotlarski* , *Daniel Lüthi* , *Christoph Schär*
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Climate models are subject of high parametric uncertainty induced by poorly confined model parameters of parameterized physical processes. These uncertain model parameters are typically calibrated in order to increase the agreement of the model with available observations. The common practice is to adjust uncertain model parameters manually, often referred to as expert tuning, which lacks of objectivity and transparency of the use of observations. This lack of information often hinders model inter-comparison and the implementation of new model parameterizations. Methods which would allow to systematically calibrate model parameters are unfortunately often not applicable to state-of-the-art regional climate models due to computational constraints facing the high-dimensional problem. Here we present an approach which is able to systematically calibrate a regional climate model (COSMO-CLM) over a European domain. The optimization is performed using a quadratic meta-model, which is a computationally cheap surrogate of the regional climate model. Five model parameters originating from different parameterizations have been selected for the calibration according to their sensitivity on the model performance. The calibration is compared to an ensemble of the same model which has undergone expert tuning to find optimal settings for the coming CORDEX simulations. In comparison to the CORDEX simulation the calibration yields similar optimal model configurations, but leading an additional reduction of the model error of 10%. The performance range captured is much wider than sampled with the expert tuned ensemble and allows to determine substantially different parameter settings which improve the model performance. The effectiveness and objectivity clearly speaks in favor of the method presented in comparison to expert tuning and could be considered as a standard procedure after new model implementations or spatial transfer of regional climate models.

2B6.5 ID:5374 11:45

The role of the driving data in simulating deep convective events with the Canadian RCM.

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The Canadian RCM is used to study the occurrence of deep convective events over North America under a changing climate. To discriminate severe environmental conditions, vertical wind shear and CAPE are used and are compared directly to the convective precipitation output produced by the convective scheme (Bechtold-Kain-Fritsch) of the model. Simulations driven by reanalysis are used to study the 1960-2000 historic period, while simulations driven by different GCMs are used for the projected transient climate, covering 1960-2100.

The occurrence of severe events increases over time and is mostly independent of the driving data, but the number of severe events captured in each simulation depends on the driving data. This presentation will emphasize the differences among simulations according to the type of driving data: different GCMs, different GCM members, and different reanalysis.

Advances in verification of forecsats / Avancées en vérification des prévisions

Room / Endroit (Ovation), Chair / Président (Bertrand A. Denis), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B4.1 ID:5706 10:30

Verification as diagnosis: Performance diagrams for numerical forecasts of severe precipitation in California during the HMT winter exercises

Barbara Brown [1], *Edward Tollerud* [2], *Tara Jensen* [1], *John Halley Gotway* [1], *Paul Oldenburg* [1], *Stanislav Stoytchev* [2], *Brian Etherton* [2]
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For three winter seasons the Hydrometeorological Testbed (HMT) has collaborated with the Developmental Testbed Center (DTC) to assess numerical forecasts of severe precipitation events in the California Coast Ranges and Sierra Nevadas. These assessments have primarily focused on verification of quantitative precipitation forecasts (QPF). In addition to providing scenario-specific direct comparison between several research and operational modeling systems, the full range of verification results (including traditional categorical scoring, probability-based scores, and newer object-based spatial statistics) have also provided useful diagnostic information about modeling options. For instance, the value of high-resolution nested domains, the relative performance of different microphysical schemes, and the impacts of choices between verification data sets (e.g., analyses vs. point precipitation observations) have been investigated. We present some salient results from these comparisons by particularly focusing on display options that maximize usefulness by combining several scores on so-called ‘performance diagrams’. Also presented are object-based scoring results produced by the Model Evaluation Tools (MET) and the MET Object-based Diagnostic Evaluation tool (MODE) applied to observed and forecast objects on spatial precipitation fields.

2B4.2 ID:5357 10:45

A new verification index for Canadian Weather Warnings

Lawrence Wilson [1], *Andrew Giles* [2]

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Weather warnings that are issued by Environment Canada differ from the regularly issued forecasts in two important ways. First, they describe impending hazardous weather conditions, usually extremes of rain snow or wind, or freezing rain. Second, the forecaster has full control over if and when to issue the warning. Given the strong relationship between predictability and lead time for most atmospheric variables, the lead time of forecasts is not independent of accuracy; forecasts issued earlier, with longer lead time, will tend to be less accurate than forecasts issued closer to the start time of the event.

A new verification index has been created to measure these two complementary qualities of the forecast, lead time and accuracy. Called the Weather Warning Accuracy and Timeliness Index (WWATI), it uses the recently-developed extremal dependency score (EDI) for the accuracy component, to which is added a timeliness factor, determined with respect to target lead times which have been preset and which are considered to give adequate time for forecast users to prepare for the onset of the severe weather. The score is structured on a range of 0 to 10, with 0 meaning no lead time regardless of accuracy or no accuracy regardless of lead time, and 10 meaning a perfect score. The benefit assigned to longer lead times is limited to half the difference between the accuracy score value and the perfect score, in keeping with the principle that the only way to get a perfect score is to give a perfect forecast with at least adequate lead time.

The new index has been tested on Canadian warning data from 2009 and 2010. The presentation will consist of a description of the score and its design considerations, and test results based on the two years of data will be shown.

2B4.3 ID:5636 11:00

On the performance of analog-based post-processing methods for several NWP models and meteorological variables

Badrinath Nagarajan [1], *Luca Delle Monache* [1], *Daran Rife* [2], *Keith Searight* [1], *John Pace* [3]
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Recently Delle Monache et al. (2011) have introduced two new analog-based methods to improve 10-m wind speed forecast produced by the WRF model over central USA. The first method (ANKF) consists in running a bias-correction algorithm based on the Kalman filter (KF) in analog space rather than in time. The analog of a forecast for a given location and time is defined as a past prediction that matches selected features of the current forecast. The second method is based on the analog concept (AN): it is the weighted average of the observations that verified when the 10 best analogs were issued.

We have tested several post-processing methods on forecasts from the Global Forecast System (GFS), North American Mesoscale (NAM) and Rapid Update Cycle (RUC) models from National Center for Environmental Prediction (NCEP). The post-processing methods were applied to 72-h (12-h) forecasts from GFS and NAM (RUC) over the whole CONUS domain for a 15-month study period, and to 10-m wind speed, 2-m temperature and relative humidity. When compared to the raw prediction, a simple 7-day running mean bias correction, and a post-processing algorithm inspired by the KF, ANKF and AN exhibit considerably lower systematic error (i.e., bias), lower random error (i.e., central root mean squared error), and a higher correlation (Spearman's correlation), across the different models, variables, forecast lead times and the spatial domain considered.

2B4.4 ID:5667 11:15

Verification of Canadian Precipitation Analysis (CaPA) for the Canadian Prairies

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The Canadian Precipitation Analysis (CaPA) is an assimilated precipitation product developed and distributed by the Meteorological Service of Canada that combines quantitative precipitation forecasts from the GEM Regional model with in-situ observations to produce a gridded precipitation estimate. The resulting product is a 6 or 24 hour estimate of liquid water equivalent precipitation at a spatial resolution of 15km. One of the current users of CaPA is Agriculture and Agri-Food Canada (AAFC) who use the product to add spatial value to often sparse in-situ precipitation observations.

CaPA is capable of assimilating most in-situ precipitation observations and employs some automated quality control checks to eliminate bad observation data. Routine verification checks are performed on the product by removing select synoptic precipitation observations from the assimilation which are then used as control checks. However, the density of these synoptic stations varies with region with fewer stations available on the Prairies than are available in Eastern Canada. This study employs additional automated stations on the Prairies for more extensive verification. For liquid precipitation events, automated observations are normally assimilated by CaPA and will need to be selectively removed for control. For solid precipitation, these station observations are automatically removed from the assimilation due to known and substantial systematic biases in the gauge measurement of snowfall. For verification purposes, these gauge measurements of snowfall are adjusted using Wind Speed – Catch Efficiency relationships developed for the Prairies, and then used for intercomparison with the spatially interpolated CaPA product. Similar verification analyses are suggested for other regions using adjusted and non-assimilated in-situ precipitation data.

2B4.5 ID:5426 11:30

Impacts of Analysis Choice on QPF Verification: StageIV and the CCPA as Verification Datastreams

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Precipitation estimates with complete spatial coverage (i.e., analyses) are desirable for forecast verification, particularly in hydrologic field projects such as NOAA's Hydrometeorological Testbed experiment in California, HMT-West. Two such precipitation estimates, the Stage IV and the Climatology-Calibrated Precipitation Analysis (CCPA) are directly compared, with the goal of determining the best observations to use in verification activities for HMT West and as a way to assess the impact of analysis choices on QPF verification scores

Stage IV is an amalgam of multisensor precipitation analyses produced by the River Forecast Centers over the continental United States. Some manual quality control is done at each River Forecast Center. The CCPA is a statistical adjustment of Stage IV data toward a Climate Prediction Center precipitation analysis.

The goal of this product is to maintain the fine scale structures of Stage IV while providing a precipitation estimate that is climatologically closer to the Climate Prediction Center's Unified Precipitation Analysis.

Comparisons of these products cover dates from 2004 to 2011, for precipitation accumulations over both 6 and 24 hour periods at a variety of precipitation thresholds. Traditional and object based statistics are compared, with many results available over the smaller HMT regions of interest.

The two products are quite similar, as expected. However, the CCPA exhibits lower spread in precipitation values than does the Stage IV. Thus, extremes are more often found in the Stage IV than in the CCPA. When used as verification data for the HMT-West, the CCPA generally produce poorer scores than do StageIV estimates. The Stage IV product was chosen for use for the 2011-2012 HMT verification activities, to provide consistency with prior years and to allow for the capture of extreme rainfall events.

2B4.6 ID:5591 11:45

Verification Working Group Initiative at CMC (part 1)

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A project has recently been launched to consolidate NWP verification efforts at the Canadian Meteorological Centre.

For NWP producing Centres, verification is a critical component to the development, monitoring and performance tracking of NWP systems. While most systems at CMC have a corresponding verification package, the overall verification effort is spread out and somewhat inefficient and not all packages are operationally supported. It has become increasingly evident that tools and mechanisms need to be consolidated so that the development, transfer to operations and maintenance of verification packages can be better coordinated. The ultimate goal is to have a consistent set of tools suitable for use by the R&D and Operational components across CMC and to have an operationally supported verification package for each operational NWP system.

This presentation will give an overview of operational verification systems at CMC and cover aspects of transfer from R&D to operations.

Atmosphere, Ocean and Climate Dynamics PART 1/ Dynamique de l'atmosphère, des océans et du climat PARTIE 1

Room / Endroit (Création), Chair / Président (Ronald J. McTaggart-Cowan), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B8.1 ID:5356 INVITED/INVITÉ 10:30

Impact of Tropical Cyclones and Transient Polar Disturbances on the North Pacific Subtropical Jet: Downstream Baroclinic Development and a Subsequent Intense Cyclone Event over the United States

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Observations suggest that the latitudinal location, longitudinal extent, and overall strength of the North Pacific subtropical jet (STJ) can vary on intraseasonal and synoptic time scales in response to poleward-directed diabatically driven upper-level outflow associated with tropical heating anomalies and tropical cyclones (TCs), and equatorward-directed flow associated with the passage of higher latitude transient baroclinic disturbances. This presentation will focus on the role that tropical disturbance-related diabatically driven outflow over the Bay of Bengal and western North Pacific collectively played in conjunction with higher latitude transient disturbances in strengthening the North Pacific STJ. After this strong STJ entered western North America it helped to trigger a record-breaking intense cyclone event (< 960 hPa) downstream over the Upper Midwest on 25-26 October 2010 that is illustrated by a case study.

The record-breaking Upper Midwest cyclone originated from a lee trough east of the Rockies and rapidly developed as a very strong (150+ kt) zonally elongated North Pacific STJ crossed the Rockies. The associated zonally elongated STJ-related strong meridional thermal gradient in the upper troposphere was produced by the juxtaposition of poleward- and eastward-moving plumes of warm air that ascended from the planetary boundary layer in the vicinity of North Pacific TCs and tropical depressions to the level of the STJ and equatorward- and eastward-moving plumes of cold air that originated over northern Asia and remained in the middle and upper troposphere. A noteworthy aspect of the 25-26 October Upper Midwest cyclone was the relative absence of low-level baroclinicity in the storm environment. The development of this intense Upper Midwest cyclone will be compared and contrasted with the equally intense Ohio Valley cyclone of 25-26 January 1978 (“Cleveland Superbomb”) that featured coupled upper-level jets and abundant baroclinicity throughout the troposphere.

2B8.2 ID:5365 11:00

Multiscale Analyses of Inland Tropical Cyclone–Midlatitude Jet Interactions: Camille (1969) and Danny (1997)

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The purpose of this presentation is to document the synoptic background and underlying mesoscale processes that led to inland flooding associated with Tropical Cyclone (TC) Camille (1969) and the inland reintensification of TC Danny (1997). Severe inland flooding occurred over west-central Virginia on 20 August 1969 as the remnants of TC Camille interacted with a lower-tropospheric baroclinic zone beneath the equatorward entrance region of an upper-level jet over mountainous terrain. The worst of the flooding occurred over West Nelson Country, Virginia, where 690 mm of rain were recorded. On 24 July 1997, TC Danny reintensified unexpectedly back to tropical storm strength over northeastern North Carolina as it interacted with a lower- tropospheric baroclinic zone beneath the equatorward entrance region of an upper-level jet. Sustained winds around TC Danny increased from 10 m s^{-1} to 20 m s^{-1} and the central pressure decreased from 1012 hPa to 1000 hPa before it emerged over the Atlantic Ocean east of Virginia. This increase in sustained wind speed and decrease in central pressure while TC Danny was inland is the largest observed in comparison to nine other TCs in a 61-year list (1950–2010) of inland reintensifying TCs

over the eastern United States.

ERA-40 and the NCEP CFSR (Climate Forecast System Reanalysis) global gridded datasets, available at 1.125° and 0.5° resolution, are used to construct multiscale analyses for the TC Camille and TC Danny cases, respectively. The synoptic features associated with both events are documented and discussed, with an emphasis on the interaction between each TC and a midlatitude upper-level jet. Detailed surface analyses are employed to identify and document the life cycles of significant mesoscale features associated with both storms. Hourly radar summary charts are used in the TC Camille case study to track the evolution of the precipitation over west-central Virginia. WSR-88D radar datasets and satellite imagery are used to identify structural changes in the convective and stratiform precipitation around TC Danny as it reintensified. A potential vorticity (PV) perspective is employed to facilitate the interpretation of the multiscale analyses.

Results suggest that the inland flooding associated with the passage of the remnants of TC Camille across the Appalachians can be attributed to: (1) enhanced tropospheric-deep ascent beneath the equatorward entrance region of a downstream 45 m s^{-1} upper-level jet; (2) a moist, lower-level southerly flow that ascended over a lower-tropospheric baroclinic zone; (3) a 3–4°C 100 km^{-1} surface baroclinic zone that served as a focus for frontogenesis and mesoscale ascent; and (4) heavy upslope precipitation in the mountains. The inland reintensification of TC Danny can be attributed to: (1) frontogenesis along an ~2°C 100 km^{-1} surface baroclinic zone and associated tropospheric-deep ascent beneath the equatorward entrance region of a 35 m s^{-1} upper-level jet; (2) deep convection that provided a source of diabatic heating that reinforced the ascent near the storm center and increased lower-tropospheric vorticity; and (3) negative PV advection by the diabatically driven upper-level outflow that acted to strengthen the downstream meridional PV gradient and associated jet.

2B8.3 ID:5544 11:15

Mesoscale Energy Spectra in Moist Baroclinic Waves

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Various theories have been proposed over the last few decades for the atmospheric mesoscale energy spectrum, which is frequently observed to have an approximately -5/3 power law. Recent work has converged on the hypothesis that it results from a downscale cascade from synoptic scales, but the details of this cascade (i.e. the relative importance of inertia-gravity waves, stratified turbulence, etc.) is still being worked out. This talk will examine the role of moist processes in the mesoscale cascade. A number of recent computational studies have reproduced the observed spectrum, but sensitivity to moisture has been reported. In this work, we evaluate the effects of moisture on the mesoscale spectrum in idealized baroclinic life cycle simulations. Experiments are initialized with an unstable mid-latitude jet; moist physics are included but topography, radiation, and surface fluxes are omitted. Even with this idealized setup, a variety of realistic mesoscale features is found to develop. We will discuss how the simulated spectrum varies with humidity at different stages of evolution of the baroclinic wave. The importance of latent heating in the direct excitation of the mesoscale will be assessed, and implications for the mesoscale cascade theories will be discussed.

2B8.4 ID:5629 11:30

Dynamics of atmospheric response to middle latitude diabatic forcing

Hai Lin

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In recent studies, evidence was found that the wintertime Northern Hemisphere atmospheric circulation is influenced by the autumn Tibetan Plateau snow cover anomaly. An above normal snow cover 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 the southeastern United State, a structure very similar to the positive phase of the Pacific-North America (PNA) pattern. This process is likely responsible for the extreme winter condition of 2009-2010, which was characterized by the warmest and driest conditions in the past 60 years over Canada and persistent below-normal temperatures across much of the United States, Europe and northern Asia. To study the dynamics of the atmospheric response to snow cover anomaly, a promative equation atmospheric model is forced with an anomalous middle latitude thermal forcing. Different aspects of the dynamical process involved in the extratropical response are analyzed. In particular, the sensitivity to forcing location as well as to the atmospheric basic flow is discussed.

2B8.5 ID:5461 11:45

Large-scale influences on the genesis of Tropical Cyclone Karl (2010)

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The events leading up to the genesis of Tropical Cyclone (TC) Karl (2010) pose a unique opportunity to examine the continuing problem of understanding tropical cyclogenesis. The precursor disturbance to Karl originated from a cluster of showers east of the Windward Islands and was well sampled by ongoing field campaigns, particularly the PRE-Depression Investigation of Cloud-systems in the Tropics (PREDICT) as it progressed westward. The purpose of this presentation is to examine the evolution of the pre-Karl disturbance from a synoptic and equatorial wave perspective. From the synoptic perspective, one of the major factors in the initial spin-up of pre-Karl is a surge of southerly winds from northern South America on 8-9 September 2010, leading to the formation of a nearly closed earth-relative circulation. This circulation weakened late on 10 September and remained weak through 13 September, during which time the vertical wind shear created a tilted disturbance that only sporadically produced sustained deep convection. By 13 September, more persistent convection developed and pre- Karl was classified as a tropical cyclone. From the equatorial wave perspective, both the initial spin-up and subsequent shearing of pre-Karl can be tied to the phases of a convectively coupled Kelvin wave (CCKW). The observed formation of the nearly closed circulation on 9 September is well timed with the passage of the convectively active phase of a CCKW and the associated westerly wind anomalies. These westerly zonal wind anomalies have been associated with increased in the frequency of TC genesis. Physically, this increase is commonly attributed to the generation of cyclonic vorticity and a reduction in climatological shear over the western Atlantic. Further, the internal dynamics of a CCKW promote convective activity via the enhancement of low-level convergence and upper-level outflow. It is shown that both synoptic and equatorial wave modes likely contributed to the genesis of TC Karl.

AMS-NWP-WAF: Overview of operational systems

PART 2 / Survol des systèmes opérationels PARTIE 2

Room / Endroit (Inspiration), Chair / Président (Gilbert Brunet), Date (30/05/2012), Time / Heure (10:30 - 12:00)

2B1.1 ID:5709 INVITED/INVITÉ 10:30

Toward a reorganization of the numerical weather prediction suites at Environment Canada.

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Environment Canada provides weather forecasting services for a large spectrum of space and time scales. Currently, the deterministic (single forecasts) and probabilistic (ensemble of forecasts) suites are distinct systems. In the scope of increasing the efficiency of the research and development process, easing the technology transfer from research and development to operations, and simplifying the overall picture of forecast suites, a new framework is being developed. This framework consists of unifying the deterministic and ensemble forecast systems into a single system with ensemble-based hybrid data assimilation. Such unification can be achieved for the global systems as well as for the regional systems. For kilometer-scale forecasts over Canada, the multiple limited-area windows will be replaced by a single window across Canada, including a dedicated high-resolution data assimilation system. This 5-year plan will be presented and discussed.

2B1.2 ID:5497 11:00

An overview of NRL's atmospheric global modeling and research

Carolyn Reynolds , *Maria Flatau* , *Timothy Hogan* , *Y.-J. Kim* , *Rolf Langland* , *Ming Liu* , *Justin Mclay* , *Jonathan Moskaitis* , *Melinda Peng* , *James Ridout* , *Kevin Viner* , *Timothy Whitcomb*
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An overview of recent developments in NRL's atmospheric global modeling and research section will be presented. Topics briefly presented will include an update on the new Navy Global Environmental Model (NAVGEM) including a) the implementation of semi-Lagrangian advection, b) the impact of an advanced radiative transfer model and prognostic clouds, and c) continued development of the NOGAPS Emanuel scheme and implementation of the Simplified Arakawa Schubert scheme. Topics covered on ensemble design will include the impact of stochastic forcing and parameter variations, as well the impact of model formulation on tropical cyclone ensemble forecasting. Results from data denial studies from T-PARC/TCS-08, as well as decadal simulations with prescribed surface conditions, will also be shown briefly.

2B1.3 ID:5396 11:15

Inter-Comparison of the AFWA Operational and RRTMG-Replacement Configurations using WRFv3.3.1

Michelle Harrold , *Jamie Wolff* , *John Halley Gotway* , *Paul Oldenburg* , *Zachary Trabold*
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The Weather Research and Forecasting (WRF) model is a mesoscale numerical weather prediction system used in both research and operational forecasting applications. The model is highly configurable to the users' requirements and suitable for a broad spectrum of weather regimes. Due to the flexibility offered by the model, it is necessary to rigorously test select configurations and evaluate the performance for specific applications. The Developmental Testbed Center (DTC) performed extensive testing and evaluation with the Advanced Research WRF (ARW) dynamic core for two physics suite configurations, with a goal of assessing the forecast and computational performance of the updated Rapid Radiative Transfer Model (RRTMG) long- and short-wave radiation schemes. One configuration was based on the Air Force Weather Agency's (AFWA) Operational Configuration, while the second configuration substituted AFWA's current operational long- and short-wave radiation schemes (RRTM/Dudhia) with the RRTMG radiation schemes. This presentation will focus on assessing the forecast performance of these two configurations; both configurations were run over the same set of cases, allowing for a direct comparison of performance between the two. The evaluation includes a forecast period from 2 June 2008 to 31 May 2009, with forecasts being initialized every 36 hours; this extensive testing period allows for robust results as well as the ability to investigate seasonal performance of the configurations. Results will focus on the evaluation of traditional verification metrics for surface and upper air variables, along with an assessment of statistical and practical significance. A brief analysis of computational resources required to run each configuration will also be discussed.

2B1.4 ID:5627 11:30

The Developmental Testbed Center: Facilitating Transition from Research to Operations in Numerical Weather Prediction

Louisa Nance [1], *Ying-Hwa Kuo* [1], *Barbara Brown* [1], *Zoltan Toth* [2]

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The Developmental Testbed Center (DTC) is a distributed center, located in Boulder, Colorado, with a mission to facilitate the transition of numerical weather prediction (NWP) research innovations to operations. The two primary units of the DTC are affiliated with the Joint Numerical Testbed of NCAR's Research Application Laboratory and the Global Systems Division of NOAA's Earth System Research Laboratory. To fulfill its mission, the DTC focuses its efforts on two general areas: (1) code management and users support for community NWP systems, and (2) performing testing and evaluation of community NWP systems with a focus on mesoscale applications. Currently, the DTC contributes to code management and user support for the Weather Research and Forecasting (WRF) modeling system, the WRF for Hurricanes system, the Grid-point Statistical Interpolation (GSI) data assimilation system, and the Model Evaluation Tools (MET) verification package. The user support provided for all the systems includes annual resident tutorials, online tutorials, workshops, help-desk and documentation. All community code efforts involve close partnerships with the relevant active developer groups. Examples of community system testing and evaluation include WRF physics testing, testing of WRF community repository code for operational hurricane prediction, data assimilation impact studies, and ensemble configuration testing. In addition, the DTC also organizes special workshops on important challenges that are facing the NWP community. A recent example is the NWP Workshop on Model Physics with an Emphasis on Short-Range Prediction, held at NCEP/EMC in July 2011. The DTC also hosts a Visitor Program to facilitate interactions between the research and operational NWP communities. In this presentation, we will highlight results of recent DTC testing and evaluation activities with a focus on transitioning research to operations and discuss our vision for the future direction of the DTC.

2B1.5 ID:5330 11:45

Review of NCEP GFS Forecast Skills in 2011 and Beyond

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This presentation reviews NCEP GFS forecast skills in the past 20 years, with a focus on its performance in 2011. The evaluation includes 1) anomaly correlation, bias and root-mean square errors of geopotential height, temperature and wind, 2) precipitation skill scores, and 3) hurricane track and errors. The performance of GFS will be compared with that of a few other international NWP models, including ECMWF, UKMO, CMC, FNOMC and JMA. Major changes in GFS dynamics, physics and data assimilation schemes and significant improvements in GFS forecast skills in the past decade will be highlighted. Results from an experimental high-resolution semi-lagrangian GFS will be presented at the end.

The Tohoku (Japan) tsunami: Observations, modelling and lessons for Canada / Le tsunami du 11 mars 2011 à Tohoku (Japon) : observations, modélisation et leçons pour le Canada

Room / Endroit (Symphonie 1), Chair / Président (Roy A. Walters), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C5.1 ID:6185 14:00

Japan tsunami marine debris

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In addition to causing untold loss of life, The tsunami generated by the Tohoku earthquake of 11 March 2011 swept a large and varied mass of debris from the coast of Japan into the North Pacific. Much of this debris remains floating in the ocean and is being transported towards the west coast of N. America. The fate of the debris and its possible impacts on the coast of British Columbia has been a subject of intense speculation and media attention. This talk will review the present state of knowledge regarding the Japan tsunami marine debris and discuss anticipated developments.

2C5.2 ID:5815 14:00

The global reach of the 2011 Tohoku tsunami

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The MW 9.0 Tohoku earthquake of 11 March 2011 that occurred off the northeastern coast of Honshu Island, Japan generated a highly catastrophic tsunami, the strongest in the Pacific region since 1964. Large amplitude tsunami waves were recorded throughout almost the entire Pacific Ocean with maximum recorded trough-to-crest wave heights of over 2-3 m on the coasts of Alaska and the Aleutian Islands, 1-1.6 m on the coast of British Columbia, over 3-5 m on the coasts of Oregon and California, greater than 2-3 m on the Mexican coast and up to 4-5 m on the Pacific coast of South America. Moreover, observations indicate that the Tohoku tsunami penetrated into the Atlantic Ocean through Drake Passage and was clearly recorded at several island stations in the Southern Atlantic and on the Atlantic coast of South America. The tsunami was also recorded by a great number open-ocean DART stations and by the geophysical in NEPTUNE-Canada observatory. The observational data were thoroughly examined statistical and spectral parameters were estimated and spectral characteristics of the source area were reconstructed. To simulate the 2010 Tohoku, we used a shallow-water finite-difference model formulated in a spherical geographical coordinate system. Computations are based on a 2-min ETOPE2 topographic grid. The source for the 2011 event was the finite failure model of Gavin Hayes (NEIC). The model results were found to be in good agreement with observations and show two main branches of the tsunami energy flux: (1) a northeastern branch which propagated to the West Coast of the USA, Mexico and the northern part of South America; and (2) a southeastern branch that propagated to the coast of Chile.

2C5.3 ID:5767 14:15

Distribution functions of runup heights of the 1896, 1933 and 2011 Japanese tsunamis in the Sanriku area

Efim Pelinovsky [1], *Byung Ho Choi* [2], *Byung Il Min* [2], *Yoshinobu Tsuji* [3], *Kyeong Ok Kim* [4]

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Data from a field survey of the 2011 tsunami in the Sanriku area of Japan is presented and used to plot the distribution function of runup heights along the coast. It is shown that the distribution function can be approximated using a theoretical log-normal curve [Choi et al, 2002]. The characteristics of the distribution functions derived from the runup-heights data obtained during the 2011 event are compared with data from two previous gigantic tsunamis (1896 and 1933) that occurred in almost the same region. The number of observations during the last tsunami is very large (more than 5,247), which provides an opportunity to revise the conception of the distribution of tsunami wave heights and the relationship between statistical characteristics and number of observations suggested by Kajiura [1983]. The distribution function of the 2011 event demonstrates the sensitivity to the number of observation points (many of them cannot be considered independent measurements) and can be used to determine the characteristic scale of the coast, which corresponds to the statistical independence of observed wave heights.

2C5.4 ID:5449 14:30

Fast Tsunami Predictions with the All-Source Green's Functions and the GPS-Aided Source Functions --- Illustrated by the 2011 Tohoku Tsunami

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This paper proposes a new approach on how to predict tsunamis almost instantaneously when a submarine

earthquake breaks out. The new approach is comprised of quick generation of a tsunami source and an instantaneous transfer of the source to a tsunami arrival time series at one or several points of interest. The seismic data and the coastal GPS-station displacements sensed by the satellites are all used to derive the tsunami source in real-time. The derived tsunami source consists of the initial sea surface elevations and the water depth averaged initial velocities. The instantaneous transfer of a source function to the arrivals at a point of interest is realized by an all-source Green's function (ASGF), which is pre-calculated for the destination point. The ASGF can operate on a source function originated anywhere in the oceans and allows the resolution of the source function as fine as the model's native resolution. The new approach is verified with the 2011 Tohoku tsunami data measured by the DART buoys.

2C5.5 ID:5532 14:45

Japan 2011 tsunami: characteristics of wave propagation from observations and numerical modelling

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We used a numerical tsunami model to describe wave energy decay and transformation in Pacific Ocean during the 2011 Tohoku tsunami. The numerical model was initialized with the results from a seismological finite failure model and validated using deep-ocean bottom pressure records from DARTs, from the Neptune Canada cabled observatory, as well as data from four satellite altimetry passes. We use statistical analysis of the available observations collected during the Japan 2011 tsunami and of the corresponding numerical model to demonstrate that the temporal evolution of tsunami wave energy in Pacific Ocean leads to the wave energy equipartition law. Similar equipartition laws are well known for wave multi-scattering processes in seismology, electromagnetism and acoustics. We also show that the final near-equilibrium state is governed by this law: after the passage of the tsunami front, the tsunami wave energy density tends to be inversely proportional to the water depth. This fact leads to a definition of tsunami wave intensity, which is simply energy density times the depth. This wave intensity fills the Pacific Ocean basin uniformly, except for the areas of energy sinks in Southern Ocean and in Bering Sea.

2C5.6 ID:5430 15:00

A tsunami generated by a Cascadia subduction zone event.

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An unstructured-grid numerical model is used to simulate a tsunami generated by an Mw 9 Cascadia subduction zone event. The purpose of these simulations is twofold: to assess inundation using a high resolution grid in the area around Ucluelet, and to provide a test bed for numerical models that can be used in evaluating the variation in results. The model results are very dynamic with high amplitude (up to 7 m), short period (10's of minutes) waves that create extensive inundation and overtop roadways such that the flow becomes transcritical. Some of the high velocity and high Froude number flows are similar to tidal rapids, although on a much shorter time-scale. The results are in agreement with paleotsunami studies that describe the 1700 megathrust event.

2C5.7 ID:5701 15:15

Exploration of the possibility of using long-range acoustic telemetry to expand West Coast tsunami early warning system

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Many earthquakes occur to the west and north of Canada's west coast, particularly in the Alaskan Panhandle and the Aleutian Islands. Tsunamis generated by these earthquakes tend to arrive at British Columbia's coast from the north. Current monitoring systems to identify and warn of tsunamis do not cover this area, reducing the quality and capability of existing real-time predicting tools, and shortening the response time for communities along the west coast. Tsunami warning systems presently exist, but rely on radio link via surface buoys to acquire the data in a timely fashion. These systems are very expensive to build, deploy, and maintain. It is especially difficult to maintain surface buoys in many offshore locations due to harsh conditions and limited ship time. Here we discuss the possibility of using existing technology, developed for tracking neutrally buoyant floats, and the deep sound channel in the ocean to telemeter data from bottom mounted pressure sensors over long distances to hydrophones deployed closer to shore and constantly monitored by the NEPTUNE Canada network. Pros and cons of such a system will be discussed and bandwidth limitations and data coding schemes will be explored.

Regional Climate Modelling and Climate Projections PART 2 / Modélisation du climat régional et projections du climat PARTIE 2

Room / Endroit (Symphonie 2), Chair / Président (Laxmi Sushama), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C6.1 ID:5854 INVITED/INVITÉ 14:00

Linking climate change modelling to impacts studies: recent advances in downscaling techniques for hydrological extremes

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Although a large published literature exists on the strengths and weaknesses of downscaling methods for different climatic variables, in different regions and seasons, little attention is given to the choice of downscaling method when examining the impacts of climate change on hydrological systems and, in particular, extremes. There is a need to move away from comparison studies into the provision of decision-making tools for planning and management that are robust to future uncertainties; with examination and understanding of uncertainties within the modelling system. This talk will examine the downscaling concept, the results from comparative studies and new downscaling methods for extreme rainfall.

Regional Climate Models (RCMs) simulate the magnitude and spatial pattern of observed daily extreme

rainfall events more reliably than GCMs but still underestimate extreme rainfall in relation to observations. All RCMs have deficiencies in their representation of the magnitude and spatial variability of daily rainfall extremes. Though boundary forcing has the greatest impact on the magnitude of extremes in RCM simulations, changes in RCM specific formulations also lead to local-scale differences in biases and response to forcing. Recent research also shows that RCM simulation of extreme rainfall is better for long (e.g. 5 to 10 days) rather than short duration events and is best for the winter season when extreme rainfall is mostly associated with synoptic and mesoscale precipitation structures. Simulation of extreme rainfall is particularly poor in summer when convection dominates.

This presentation will evaluate the ability of RCMs to represent extreme precipitation processes and then present a new NERC-funded project that is investigating model deficiencies in the simulation of extreme rainfall. This is, for the first time, running a high resolution (1.5km) regional climate model over the UK to investigate the effect of model resolution on the simulation of extreme precipitation and to produce new estimates of future change to convective extremes for pluvial flood risk.

2C6.2 ID:5421 14:30

Sensitivity of seasonal precipitation extremes to model configuration of the Canadian Regional Climate Model over eastern Canada using historical and future climate simulations

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Since Regional Climate Models (RCMs) with high spatial resolutions use the outputs from Atmosphere-Ocean Global Climate Models (AOGCMs) as boundary conditions, uncertainties in climate change simulations incorporate the combined errors from the AOGCM-RCM cascade or from the downscaling procedure itself and its configuration (domain size, physical parameterization, etc.). This study analyzes the uncertainty of seasonal precipitation extremes as simulated by the version 4.2.3 of the Canadian RCM (CRCM), considering three main sources of uncertainty: a) the domain size, b) the driving AOGCM and c) the choice of member for a given AOGCM. Precipitation from eighteen simulations is analyzed, covering the historical (1961-1990) and future (2041-2070) period (10 over the current period, and 8 over the future one). These simulations are driven by 2 AOGCMs (i.e. CGCM3, member # 4 and # 5, and ECHAM5, member # 1 and # 2), and one set of re-analysis products(i.e. ERA40), using two domain sizes (AMNO, covering all North America and QC, a smaller domain centered over the Province of Québec). Four seasonal indices are used to characterize different types of variability and extremes of precipitation: the number of wet days (≥1 mm day-1), the maximum number of consecutive dry days (<1 mm day-1), the maximum precipitation accumulation over a period of 10 consecutive days, and the 95th percentile of the precipitation. Preliminary results show that largest source of uncertainty comes from the AOGCM selection, and the choice of the member for a given AOGCM, followed by the domain size. These three sources of uncertainties are greater than the internal variability of the CRCM, over the majority of the common spatial domain. For all extreme indices, the sensitivity of simulated variance is greater in winter than in summer, highlighting the importance of the large scale influences in the precipitation variability.

2C6.3 ID:5638 14:45

Issues related to the selection of a subset of simulations from a large multi-model ensemble

Martin Leduc [1], *René Laprise* [1], *Ramón De Elía* [2], *Leo Separovic* [1]
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Coupled Model Intercomparison Projects (CMIP) as CMIP3 or the ongoing CMIP5 are essential to provide credible ranges of climate-change projections for the next century. Such large ensembles sample structural differences between coupled Atmosphere-Ocean General Circulation Models (AOGCMs), which induce differences in their climate-change simulations. One popular application from these dataset is the use of Regional Climate Models (RCMs) that are suitable to dynamically downscale the AOGCMs' simulations and obtain small-scale features that characterize the local climate.

Due to the huge amount of resources needed for driving an RCM by using all the available simulations from a large dataset, most groups that use the data as an input to their model generally have to consider only a subset from the entire ensemble. The way of selecting a subset involves several experts' decisions, as to maximize the number of different models when minimizing the number of realizations for each model. Another type of decision is to give preponderance to models developed by different institutes to ensure a certain level of independence between the climate-change projections. Moreover, several scientific and technical constraints generally affect the experts' decisions, e.g. models can be selected according to some performance criteria, specific climatic features or the models' compatibility that includes the availability of the data needed to drive the RCM through its initial and lateral boundary conditions.

In this talk, we discuss the main issues related to the selection of a subset of simulations from the CMIP3 multi-model ensemble. The characteristics of the ensemble itself are also discussed using three sources of variability; intra-model (several realizations from the same model), intra-institute (several versions or models developed by a same institute) and inter-institute (a priori independent models).

2C6.4 ID:5392 15:00

Assessment of CMIP5 climate change projections and uncertainties over Eastern Canada

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The goal of the Coupled Model Intercomparison Project Phase 5 (CMIP5) is to provide the basis for climate change experiments that will be included in the next IPCC assessment report. The project encompasses simulations performed by the latest generation of Earth System Models along with a number of coupled atmosphere-ocean climate models performed by the climate research centers worldwide. CMIP5 climate projections are forced with recently developed Representative Concentration Pathways (RCP) containing information of greenhouse gases, aerosols and land use.

In this work we use multi-model ensemble simulations in order to estimate climate change projections over Eastern Canada. We evaluate near surface air temperature and precipitation simulated by all available climate models.

We will focus on all available CMIP5 concentration pathways (RCP85, RCP60, RCP45, RCP26), their similarities as well as the relative importance of each associated uncertainty source. Despite experimental differences between CMIP5 and its previous phase CMIP3, comparisons between both databases are attempted.

Climate Change and Extreme Events PART 1 / Changements climatiques et événements extrêmes PARTIE 1

Room / Endroit (Symphonie 3A), Chair / Président (Chad Shouquan Cheng), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C8.1 ID:5759 14:00

A comparison of nonlinear and linear statistical downscaling for future climate

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The validation of statistical downscaling methods traditionally involves using a subset of observations to evaluate the model's performance; however, this procedure does not allow the user to infer the model's future performance. To address this limitation, Vrac et al. (2007) used regional climate model (RCM) outputs as present and future "pseudo-observations" and compared them with the statistically downscaled series (SDS). Our validation methodology extends the Vrac et al. approach by validating the SDS in terms of both the daily variability and the annual climate of extreme weather.

In particular, multiple linear regression (LR), Bayesian neural networks (BNN) and Support Vector Regression (SVR) were used to statistically downscale the coarse resolution Canadian General Circulation Model (CGCM 3.1) inputs using the Canadian RCM (CRCM 4.2) daily temperatures and precipitation outputs as "pseudo-observations" for the southern Quebec and Ontario region. The historical (1968-2000) and future (2038-2070) "pseudo-observations" from 10 CRCM 4.2 grid cells were compared against the SDS for both periods in terms of (i) mean absolute errors (MAE) to determine the models’ performance in simulating the daily variability, and (ii) indices of agreement (IOA) calculated from the annual climate indices used to determine the performance in simulating the annual climate of extreme weather. This methodology allows one to evaluate the benefits of nonlinear models with respect to standard linear models in the statistical downscaling context.

2C8.2 ID:5699 14:15

High-resolution dynamical downscaling of extreme precipitation in three future climate regimes

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Extreme rainfall events present a number of challenges and questions related to public safety and risk management, and are thus of great interest to scientists, water resources managers, and the general public. As many of the environmental factors that influence intense precipitation processes are predicted to change in future climates, understanding, quantifying, and communicating possible changes in extreme precipitation

events is critical to preparing for new or changing hazards. Dynamical downscaling of climate model projections continues to gain popularity as a method to link potential changes in the large-scale climate pattern to discernible “weather” at regional and local scales. This study uses the Weather Research and Forecasting (WRF) model to dynamically downscale warm-season extreme precipitation events from regional climate model projections of past and future periods.

Precipitation events are first assessed at the regional scale, using the North American Regional Climate Change Assessment Program model dataset. Extreme precipitation events are defined using percentile-based thresholds of warm-season rainfall in the Front Range of the Colorado Rocky Mountains. The most extreme of these events are then simulated at high resolution (1.3-km grid spacing) using the WRF model to assess the influence of regional climate-scale environmental changes on storm-scale processes affecting the generation of precipitation. Historical (1979 – 2003) and future (2038 – 2070) high-resolution simulations illustrate the potential for changes in extreme precipitation across three climate model projections.

Using the WRF model to simulate the events at storm-scale resolution allows for examination of convective-scale parameters most relevant to precipitation processes. Analysis focuses on changes in overall precipitation amount, intensity, spatial distribution, and maximum terrain elevation at which extreme precipitation occurs. The ability to resolve fine-scale precipitation processes and features further provides enhanced detail with respect to precipitation type (i.e., hail/graupel vs. rain), as well as precipitation accumulation and runoff, potentially forming a more realistic picture of future flood risk.

2C8.3 ID:5745 14:30

The impacts of climate change on extreme precipitation events in the southern United States.

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Extreme precipitation events result in annual damage in excess of $2B USD, and 127 deaths per year in the US. Here, we investigate the question of how extreme precipitation events would change in a warmer climate. Previous studies have found that in a warmer climate, extreme precipitation events could increase in intensity. The water vapor content of the atmosphere is expected to increase with increasing temperatures, potentially leading to more intense heavy rainfall along with an increased risk of severe floods. For this study, we focus on the synoptically forced events over Texas, Louisiana, Mississippi and Alabama during March, April and May. We classify extreme events as those in which three or more inches of precipitation occurred within 24 h at three or more stations located at least 10 miles apart. A composite of these events is generated using North American Regional Analysis (NARR) data.

We use the Weather Research and Forecasting (WRF) model to simulate this composite event. The purpose of using WRF for this simulation is to enable the application of thermodynamic changes derived from the IPCC AR4 GCM data. We then compare the current to the future WRF simulated composite events to examine changes in intensity and structure. By using this method, we determine how current extreme precipitation events in this region could change in a warmer climate in intensity and structure, as well as identify environmental parameters that have a significant influence on the observed change.

2C8.4 ID:5308 14:45

Projected changes to precipitation extremes for Northeast Canadian watersheds using a multi-RCM ensemble

[1] [1] [1] [1] [2]

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This study focuses on projected changes to seasonal single- and multi-day (i.e. 1-, 2-, 3-, 5-, 7-, and 10-day) precipitation extremes for 21 Northeast Canadian watersheds using a multi-Regional Climate Model (RCM) ensemble available through the North American Regional Climate Change Assessment Project (NARCCAP). The set of simulations considered in this study includes simulations performed by six RCMs for the 1980–2002 period driven by National Center for Environmental Prediction reanalysis II and those driven by four Atmosphere-Ocean General Circulation Models (AOGCMs) for the current 1971–2000 and future 2041–2070 periods. Regional frequency analysis approach is used to develop projected changes to selected 10-, 30- and 50-yr return levels of precipitation extremes. The performance errors due to internal dynamics and physics of the RCMs and those due to the lateral boundary data from driving AOGCMs are studied. The use of a multi-RCM ensemble enabled a simple quantification of RCMs' structural and AOGCM related uncertainties in terms of the coefficient of variation. In general, the structural uncertainty appears to be larger than that associated with the choice of the driving AOGCM for majority of the precipitation characteristics and watersheds considered. Analyses of ensemble-averaged projected changes to various return levels show an increase for most of the watersheds, with smaller changes and higher uncertainties over the south-easternmost watersheds compared to the rest. It is expected that increases in return levels of precipitation extremes will have important implications for water resources related activities such as hydropower generation in this region of Canada.

2C8.5 ID:5364 15:00

Regional climate projections of temperature extremes: will extremes warm-up faster than average values?

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Future climate projections of extreme events can help forewarn society from high-impact events and develop better adaptation strategies. Extreme Value Theory (EVT) provides a well established and robust framework to analyze the behavior of extreme weather events for the present climate and future projections. In this study a non-stationary model for Generalized Extreme Value (GEV) distributions is used to analyze the trend of extreme temperatures in the context of a changing climate, and compare it with the trend of average temperatures.

The analysis is performed for climate projections of the Canadian Regional Climate Model (CRCM version 4.2) driven by two members (#4,#5) of the Canadian Coupled Global Climate Model (CGCM version 3.1), over North America. Annual extremes of daily minimum and maximum temperatures are analyzed. Significant positive trends for the location parameter of the GEV distribution are found, indicating an expected increase in the extreme temperature values. The trends of the annual minimum (maximum) temperatures are compared to the trends of the winter (summer) average temperatures. In some regions, extreme temperatures exhibit an increase significantly larger than that for the seasonal average temperatures.

2C8.6 ID:5341 15:15

Heat Wave Frequency Variability over North America: Two Distinct Leading Modes

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Seasonal prediction of heat wave variability is a scientific challenge and of practical importance. This study investigates the heat wave frequency (HWF) variability over North America (NA) during the past 53 summers (1958 2010). It is found that the NA HWF is dominated by two distinct modes, namely, the inter-decadal (ID) mode and the inter-annual (IA) mode. The ID mode primarily depicts a HWF increasing pattern over most of the NA continent except some western coastal areas. The IA mode resembles a tri-pole HWF anomaly pattern with three centers over the northwestern, central and southern NA, respectively. The two leading modes have different dynamic structures and predictability sources. The ID mode is closely associated with the prior spring sea surface temperature anomaly (SSTA) in the tropical Atlantic and tropical western Pacific that can persist throughout the summer, whereas the IA mode is linked to the development of El Niño Southern Oscillation (ENSO). A simplified general circulation model is utilized to examine the possible physical mechanism. For the ID mode, the tropical Atlantic SSTA can induce a Gill- type response which extends to NA, while the northwestern Pacific SSTA excites a Rossby wave train propagating eastward towards NA. These two flow patterns jointly contribute to the formation of the large-scale circulation anomalies associated with the ID mode. For the IA mode, the corresponding circulation anomalies are basically similar to a Pacific-North American (PNA) pattern. The subsidence associated with high pressure anomalies warms and dries the boundary layer, inhibiting cloud formation. The resulting surface radiative heating further warms the surface. For the low pressure anomalies, the situation is just opposite. Through such processes, these SSTAs can exert profound influences to the HWF variability over NA.

Atmosphere, Ocean and Climate Dynamics PART 2/ Dynamique de l'atmosphère, des océans et du climat PARTIE 2

Room / Endroit (Symphonie 3B), Chair / Président (Adam Monahan), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C7.1 ID:5424 14:00

2-3 January 2010 Northeast Winter Storm: A Case Study

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The snow storm of 2-3 January 2010 affected parts of the Northeast with significant snowfall and strong winds. Record single storm snowfall totals as high as 84 cm were reported in Burlington, Vermont with winds of 20-25 m/s from Maine to New York. Despite uniform precipitation type, total snowfall varied significantly over a small spatial scale, highlighting the importance of orography and other mesoscale processes. This presentation will analyze the significant large scale features that led to the unusual track of this cyclone as well as the small scale forcing mechanisms responsible for producing a record setting snowfall in Burlington, VT. Analysis of the event found that strong upper level blocking in the North Atlantic Ocean, coincident with

an extremely negative phase of the Arctic Oscillation, was responsible for the development of a large cutoff low over the northeast United States on 2-3 January. Intense cyclogenesis took place off the New England coast as a slow moving surface low pressure system retrograded southwestward into the Gulf of Maine. Snowfall over northern New England was enhanced in the equatorward exit region of an anomalous easterly jet streak over southern Quebec, as well as through upslope flow along a cold wedge of air banked up against the western spine of the Green Mountains.

2C7.2 ID:5458 14:30

Vertical scale collapse and the buoyancy Reynolds number in stratified turbulence

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Several recent articles have employed results of laboratory experiments and numerical simulations of stratified turbulence to propose scalings for the dynamics of stably stratified turbulence. These are based on the notion that stratification causes the vertical integral scale, H, to adjust to yield a vertical Froude number, Fv U/N H, of order unity at high enough Reynolds numbers. Here, U is a characteristic horizontal velocity and N is the Brunt- Vaissalla frequency. At the same time U and the horizontal length scale, L, are much less affected by the stratification, such that the horizontal Froude number, Fh U/N L, diminishes as stratification is increased. The limiting equations in this regime are hydrostatic but remain three-dimensional. This is in contrast to the more classical Fv → 0 Lilly scaling, which yields layerwise two-dimensional flow. Brethouwer et al. (2007) explored the Fv 1, Fh → 0 limit and argued it would not emerge in stratified flow unless the dissipation scale is significantly smaller than the smallest scale at which the stratification is important, the Ozmidov scale. The buoyancy Reynolds number is defined as Re_b Re H^2/L^2 , where Re is the usual Reynolds number. Its inverse multiplies the non-dimensional viscous term proportional to ∂^2 u/∂z^2, where u is a horizontal velocity component. The inertial-range requirement that viscous terms be small is clearly most problematic for this term in the Fv 1, Fh → 0 limit as it implies the vertical scale goes to zero. In addition, Lindborg (2006) reasoned that horizontal spectra of the horizontal velocity variance and the potential energy would be independent of stratification. We present direct numerical simulations of stratified flow, at unprecedented resolutions up to 2048^2 ×513 (using 768 processors), exploring these scalings. While we were still not able to achieve a wide range of stratifications unaffected by the vertical viscous term, we were able to determine that changes in the horizontal spectrum were due to the buoyancy Reynolds number and not to the stratification itself. This result is entirely consistent with previous work on the Fv 1, Fh → 0, large- Re limit as it implies the horizontal spectrum is independent of stratification.

2C7.3 ID:5403 14:45

Saturated Pseudoadiabats — A Non-iterative Approximation

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Two non-iterative approximations are presented for saturated pseudoadiabats (also known as moist adiabats). One approximation determines which moist adiabat passes through a point of known pressure and temperature, such as through the lifting condensation level on a skew-T or tephigram. The other approximation determines the air temperature at any pressure along a known moist adiabat, such as the final temperature of a rising cloudy air parcel. The method used to create these statistical regressions is relatively a new variant of genetic programming called gene-expression programming. The correlation coefficient between the resulting non-iterative approximations and the iterated data such as plotted on thermodynamic diagrams is over 99.97%. The mean absolute error is 0.28°C and the root mean squared error is 0.44 within a thermodynamic domain bounded by $-30 < \theta w \leq 40°C$, $P > 20$ kPa, and $-60 \leq T \leq 40°C$, where [θw, P, T] are [wet-bulb potential temperature, pressure, and air temperature].

2C7.4 ID:5525 15:00

Rossby waves in tropical cyclones

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Observational analyses of hurricanes in the tropical atmosphere indicate the existence of spiral rainbands which propagate outwards from the eye and affect the structure and intensity of the hurricane. These disturbances may be described as vortex Rossby waves. Under certain conditions, two concentric rings of high-intensity wind (concentric eyewalls) develop. The outer or secondary eyewall appears to be related to wave-mean-flow interactions near the critical radius where the mean flow angular velocity matches the phase speed of the waves.

In this study we carry out asymptotic analyses to examine the evolution of the interactions near the critical radius in some two-dimensional configurations on an f-plane and a beta-plane.

2C7.5 ID:5740 15:15

Response of the South Asian Summer Monsoon to Indian Ocean Dipole and ENSO

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It is well known the sea surface temperature (SST) anomalies during the Indian Ocean Dipole (IOD) and Pacific El Niño-Southern Oscillation (ENSO) events can strongly influence atmospheric circulation over Indian Ocean which further modulates South Asian Summer Monsoon (SASM). However, these two events affect SASM in different ways, depending on their phases, amplitudes and interactions. Generally deep convection occurs only with SST exceeding a threshold of 28.0 oC, thus the warm phase of IOD or ENSO bring asymmetric consequences over the SASM region. Although IOD event is a local signal, with relatively weak variation, it can directly interfere with the air circulation over Indian Ocean and adjacent land masses. On the other hand, Pacific ENSO influences SASM rainfall by a remote forcing by changing the Walker Circulation over its own basin and then modifying the location and strength of Walker Cell over Indian Ocean.

This study investigates the roles of individual and combined effect by IOD and ENSO on SASM rainfall using Community Atmospheric Model version 4 (CAM4). Control experiments are performed using monthly prescribed SST whereas climatology experiments are forced with climatological SST. In the CAM4 sensitivity experiments for both control and climatology run, SST anomalies are specified in the tropical Indian-Pacific Ocean, tropical Pacific Ocean, and tropical Indian Ocean. To reduce the uncertainties either related to internal atmospheric dynamics or model errors, for each experiment, ensemble simulations are performed to account the strength of the forced responses. Our results indicate that the warm ENSO events are basically associated with significant reductions in monsoon rainfall and widespread drought conditions over the SASM region. In contrast, during the IOD year, increased rainfall occurs over the SASM region by intensified monsoon circulation. When consider them together, the El Nino modulation of SAM rainfall vanishes and normal rainfall is seen in the CAM4 simulation.

Military Meteorology and Oceanography / Météorologie et océanographie militaires

Room / Endroit (Symphonie 4), Chair / Président (Martha Anderson), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C4.1 ID:5780 14:00

Military Weather Services Transformation Overview

Clarke Bedford [1], *Abdoulaye Harou* [2]
(Presented by *Clarke Bedford And Abdoulaye Harou*)
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The Canadian Forces are required to be able to sustain a number of deployed operations concurrently (at home and abroad) as well as the defence of Canada and North America. Weather and oceanographic services are essential enablers to military operations. Serious deficiencies have been identified in the ability of the Canadian Forces Weather and Oceanographic Service (CFWOS) to provide the required domestic and deployed specialized weather support for CF capabilities. The CFWOS has embarked on a modernization and transformation to meet present and anticipated demands.

This talk will provide an overview of the weather service activities undertaken by the CFWOS, the growing demand for support, and an update on the way ahead to meet these demands through a $25M capital project.

2C4.2 ID:5352 14:15

The Canadian Forces Joint Meteorological Centre

Edward Curtis
DND
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The Canadian Forces (CF) is required to be able to sustain a number of global deployed operations concurrently as well as the defence of Canada and North America. Weather and oceanographic services are essential to successful military operations. The Joint Meteorological Centre (JMC) at CFB Gagetown, NB continues to evolve, making the best use of modern network technologies and numerical weather prediction, while adjusting to the changing and growing military requirements of the 21st century.

The JMC weather team will consist of CF Meteorological Technicians, Environment Canada (EC) Meteorologists with supported from EC computer science specialists and CF officers and member of the rank. An environment within the JMC will be fostered, where teams of CF Meteorological Technicians (Met Techs) can properly prepare for deployments, future training of CF Meteorological Forecasters and the

centralization of weather information delivery is provided using modern communications technologies.

2C4.3 ID:5443 14:30

The Applied development cell of the Joint Meteorological Center / La cellule de développement appliqué du Centre météorologique interarmées

Marie-france Turcotte
(Presented by *marie-france Turcotte*)
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An important component of the new Joint Meteorological Center (JMC) is the inclusion of an Applied Development Cell (ADC). The major role of the ADC is to undertake projects to move CF weather support forward technically and scientifically. As an example, during the last year, the ADC provided some new experimental meteorological products during the NANOOK operation. This will be repeated for future operations. The ADC will be working closely with the JMC Standard Training Operations Liaison and Acceptance (STOLA) team in this undertaking. Another part of the ADC role is to liaise and create synergy with different groups such as Environment Canada (EC), DND and our allies The ADC is already collaborating with Defense Research Development Canada (DRDC) and EC research team to establish a framework for projects involving environmental prediction. Liaising with our allies is another important role for the ADC to seek out areas of partnership and collaboration in the production of meteorological forecast tools and research. ADC staff is part of the NATO Military Meteorology Working Group meetings and is participating in the ABCANZ (America, Britain, Canada, Australia, New Zealand) Meteorology and Oceanography working group. This presentation will provide an overview of the participation and outcome on some of the project ADC was involved in.

Une composante importante du nouveau Centre météorologique interarmées (CMI) est l'inclusion de la Cellule de développement appliqué (CDA). Le rôle principal de la CDA est de se charger de faire progresser le soutien météorologique des FC sur les plans technique et scientifique. Par exemple, dans la dernière année, la CDA a fournit de produits météorologiques expérimentaux lors de l'opération NANOOK. Ceci sera répété pour les opérations à venir. Pour ce faire, la CDA travaille en étroite collaboration avec l'équipe des Normes, instruction, liaison et acceptation opérationnelle (NILAO) du CMI. Un autre aspect du rôle de la CDA est d'établir des liens et des synergies avec différent groupes comme Environnement Canada, Ministère de la Défense nationale (MDN) et les alliés. La CDA collabore déjà avec Recherche et développement pour la défense Canada (RDDC) et un groupe de recherche à Environnement Canada pour établir un cadre de travail pour les projets en prévision environnementale. Assurer la liaison avec les allié pour établir des zones de partenariats et de collaboration dans le recherche ou la production d'outils de prévision météorologique et de recherche. La CDA est déjà engage dans les groupe de travail de météorologie militaire de l'OTAN et participera au groupe de travail ABCANZ (America, Britain, Canada, Australia, New Zealand) sur la météorologie et l'océanographie. Cette présentation donnera un aperçu des projets de la CDA.

2C4.4 ID:5432 14:45

Use of Weather Research and Forecasting (WRF-ARW) microphysics schemes to distinguish between aircraft icing types at the U.S. Air Force Weather Agency

Rebecca Adams-Selin [1], *Glenn Creighton* [2]
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Current aviation weather forecasters are required to distinguish between favorable conditions for “glaze” ice and “rime” ice, which are dependent on the size of the supercooled water drop impacting the aircraft. This distinction between glaze and rime ice is important; glaze ice is typically a more severe hazard. In general, “small” drops (producers of rime ice) have a diameter less than 50 microns, and “large” drops (producers of glaze ice) a diameter larger than 50 microns. This study evaluates the use of the U.S. Air Force Weather Agency’s (AFWA) operational Advanced Research Weather Research and Forecasting (WRF-ARW) model output fields to predict these two types of supercooled drop populations.

Within AFWA’s 4-km resolution WRF-ARW output, the only supercooled water information available is within the cloud droplet and rain drop fields. It is determined that all rain drops can be considered “large” drops, but cloud droplets are a mix of both sizes. All current AFWA WRF-ARW microphysics schemes are single-moment with respect to the cloud droplet distribution, thus cloud droplet mixing ratio is the only prognostic variable available at this time. Through evaluation of the cloud droplet size distribution assumptions made within each microphysics scheme, an empirical relation is established between cloud droplet diameter and mixing ratio. This information is then used to predict the location and amount of “small” and “large” supercooled water drops, and by extension, location and severity of glaze and rime ice. Significantly, this method does not require inline model processing and can be completed entirely through post-processing.

These predicted “small” and “large” drop fields are examined in two case studies: a mesoscale convective system over Oklahoma examined by the KOUN dual-polarized radar, and an Oregon freezing drizzle event heavily observed by the Improvement of Microphysical Parameterization through Observational Verification Experiment (IMPROVE-2) field campaign.

2C4.5 ID:5444 15:00

An overview of the progress and successes to date of the Spaceborne Ocean Intelligence Network (SOIN) project

Richard Wood [1], *Chris Jones* [2], *Paris Vachon* [3]
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The Spaceborne Ocean Intelligence Network (SOIN) is a research and operational development project that utilizes Earth-observation sensors such as RADARSAT-2, MODIS, AVHRR and MERIS to aid in military oceanographic applications for support to naval operations. The lead partner in this CSA - GRIP funded project is MetOc Halifax, with other partners including DRDC Ottawa, DFO (BIO, IML, IOS), Dalhousie University, NRL Stennis, MetOc Esquimalt, and DRDC Atlantic. One of MetOc’s primary responsibilities is the production of a bi-weekly ocean features analysis (OFA) chart to indicate the location of sea surface temperature fronts that serve as proxies for thermohaline water-mass boundaries. Such boundaries are tactically important for naval operations on both the east and west coast of Canada because of their impact on acoustic propagation. Ubiquitous cloud cover over areas of responsibility on both coasts often limits the usefulness of thermal sensors such as AVHRR and MODIS, which are major inputs to the OFA. The synthetic aperture radar (SAR) on the RADARSAT-2 satellite has the ability to penetrate clouds and detect signatures of a myriad of process that impact the ocean surface, some of which may be thermal fronts. To assist manual analysis, methods for automated detection and classification of signatures in a SAR image of the ocean surface are being developed. The aim is to classify signatures as either atmospheric or oceanographic in origin, to eliminate unimportant signatures and focus only on probable thermal front candidates. Final identification of SST front signatures will require intervention and assessment by MetOc personnel before importing them for inclusion and display on the OFA. This talk will provide an overview of the progress and successes to date as the SOIN project heads towards full implementation for naval operations in its final year.

2C4.6 ID:5754 15:15

Operational Oceanography for Naval Operations: Ocean Workstation 1.0 Upgrade

Martin Taillefer [1], *Todd Mudge* [2], *Wayne Renaud* [1], *Nikola Milutinovic* [2], *Peter Willis* [2], *Lcdr Darryl Williams* [3]

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Contact:

Modern acoustic sensor performance prediction systems require the most current environmental data as input for accurate modeling. The Canadian Navy’s Ocean Work Station (OWS) was developed in the mid-1990s to assist in the operational analysis of remotely sensed environmental data and in-situ observations, to create Sea Surface Temperature (SST) and Ocean Feature Analysis (OFA) products. These operational oceanography products are disseminated to maritime units to aid in sonar performance predictions, a key capability requirement for Canadian naval assets.

ASL Environmental Sciences Inc. (ASL) and Maritime Way Scientific Ltd. (MWS) were contracted to provide the Department of National Defence (DND) a system upgrade of the OWS in terms of its architecture and operational capability. The newly-versioned OWS 1.0 was delivered to the Navy in January 2012. OWS 1.0 imports 3D ocean model data from DFO's Canada-Newfoundland Operational Ocean Forecasting System (CNOOFS) to create more accurate OFAs and SST products; optimizes basin resolution algorithms; standardizes satellite input files and processes; and finally standardizes operating versions between MetOc Halifax and MetOc Esquimalt. OWS 1.0 ingests both source data, which is data measured in-situ by oceanographic instruments or satellite imagery, and trial field data such as CNOOFS model predicted data, seasonal or annual averages. The trial field data is used to fill gaps in spatial coverage when the source data is sparse, and the resulting weighted 2D source data map is added to the trial field data to create the final product. This significant milestone will enable DND to further advance its oceanographic capabilities and accommodate new developments in ocean modeling and forecasting. With OWS 1.0 in place, the Canadian Navy can further develop the next-generation of oceanographic modeling and operational product capability, and can be the cornerstones of future operational oceanography R&D.

DA III: Data Assimilation Methods / Méthodes d'assimilation des données

Room / Endroit (Ovation), Chair / Président (Mark Buehner), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C1.1 ID:5602 14:00

Particle Filter-based Data Assimilation for a 3D Biological Ocean Model and Satellite Observations

Jann Paul Mattern , *Michael Dowd* , *Katja Fennel*
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We employ sequential importance resampling (SIR), a particle filter technique, to assimilate satellite observations of surface chlorophyll into a 3-dimensional biological ocean model. Particle filters represent an alternative to other, more commonly used ensemble-based data assimilation techniques like the Ensemble Kalman filter. They require no assumptions about the underlying model and are thus suitable for highly nonlinear applications. However, their application in oceanographic contexts is typically hampered by the high dimensionality of the model's state space. We apply SIR to a high-dimensional (> 2 Mio. dimensional state- space) model with a small ensemble size (20) and avoid complications posed by the dimensionality by implicitly operating in a much lower dimensional error subspace. We introduce our SIR implementation which includes 2 extensions to the standard SIR procedure, a simple smoother to deal with outliers in the observations and state-augmentation which provides the SIR with parameter memory. Our goal is to test the SIR's ability to obtain improved chlorophyll estimates. For this purpose we compare the SIR results to a model simulation with optimal parameters with respect to the same set of observations. By running replicates of our main experiments, we assess the robustness of our SIR implementation. We show that SIR is suitable for satellite data assimilation into biological models and that our implementation yields comparable results to the optimized model simulation. Both extensions, smoother and state- augmentation are required for robust results and improved fit to the observations.

2C1.2 ID:5359 14:15

Nonlinear measurement function in the Ensemble-Kalman filter and a practical application of the Sigma-point Kalman filter

Youmin Tang [1], *Dake Chen* [2], *Jaison Ambandan* [3], *Manoj Kk Kk* [1]
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In this study, we explored several computational schemes of the Kalman gain of Ensemble Kalman Filter (EnKF) for nonlinear measurement function. Emphasis is placed on a comprehensive interpretation of the current algorithm and an extension of it based on statistically rigorous derivations. It was mathematically proven that the modified Kalman gain formulas can remove the implicit assumption in the current algorithm. A simple Lorenz model was used as a test bed to compare these algorithms. Experiments showed that the modified Kalman gain could perform better than the current one for the Lorenz model parameter estimate, which involves a highly nonlinear measurement function.

Another issue addressed in this study was the computational cost of the Sigma-point Kalman filters (SPKFs). The truncated single value decomposition (TSVD) method was used to construct a reduced rank SPKF. A realistic ENSO (El Nino and Southern Oscillation) forecast model was used to test the reduced rank SPKF. The performance of the reduced rank SPKF was compared to the square root Ensemble Kalman filter (EnSRF) that was designed parallel to the SPKF. The reduced rank SPKF was found to be very computationally feasible and led to smaller errors compared to the EnSRF, in terms of ENSO simulation.

2C1.3 ID:5643 14:30

MAS, a Mesoscale Analysis System that allows models to be imperfect

Dominik Jacques , *Isztar Zawadzki*
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Weather radars provide high resolution measurements of precipitation location and intensity. Using the Doppler effect, partial information about the 3D wind field can also be inferred. We are developing a system that assimilates radar data to obtain complete atmospheric analyses throughout the life cycle of convective systems. A few unique features distinguish this assimilation system from others. First, is the use of model equations as weak constraints in its cost function. This allows the model to be imperfect by not forcing a smooth trajectory during its integration. This freedom, and the low computational costs associated with this method, allow the assimilation to be performed cyclically. Every five minutes a new analysis is produced using up-to-date observations and a forecast from the previous analysis. This cycling process quickly converges to a balance between perfect resemblance with observations and the generation of spurious features in the simulation. Lastly, exponential functions are used as covariance models for both the background and the observation terms. When using these functions, inverse variance-covariance matrices (as they appear in the cost function) are very sparse. This allows matrix-vector multiplication to be efficiently performed by use of simple stencils. This improves on other assimilation systems where correlations among variables are often neglected. Examples of evolving atmospheric analyses will be presented.

2C1.4   ID:5362   14:45

Assimilation of Near Surface Observations over Complex Terrain: EnKF versus 3DVAR

Zhaoxia Pu , *Hailing Zhang*
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Surface observations are the main conventional observations. However, in modern numerical weather prediction, the use of surface observations, especially those data over complex terrain, remains a unique challenge. In this study, a series of observing system simulation experiments is first performed with two popular data assimilation methods, the three- dimensional variational data assimilation (3DVAR) and an ensemble Kalman filter (EnKF), to examine their abilities in assimilating surface observations. Results from the assimilation of a single observation demonstrate that there are fundamental problems in assimilating surface observations over complex terrain with 3DVAR. Modern EnKF could overcome some of these limitations through its flow-dependent background error term. More comprehensive comparisons are conducted using a synoptic case with two severe weather systems: a frontal system over complex terrain in the western US and a low- level jet system over the Great Plains. It is found that both 3DVAR and EnKF are capable of extending information from surface observations to the atmospheric boundary layer. Over flat terrain, both methods work well, although EnKF does slightly better in terms of the analysis and forecast of the low-level jet system. Over complex terrain, EnKF performs better than 3DVAR in general. Specifically, EnKF is more capable of handling surface data under terrain misrepresentation. However, since data are sparse over complex terrain, data rejection may not be the best solution to deal with errors due to model terrain representation.

With the confidence from EnKF method, real data assimilation experiments are also performed. Results will be reported during the conference.

2C1.5   ID:5641   15:00

Adaptive (online) estimation of error covariances parameters for data assimilation

Richard Menard , *Alain Robichaud*

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Weather an OI, EnsKF or variational method is used for data assimilation some information about observation, model or background error covariance parameters are needed. These are derived from assimilation residuals in observation space, such as OmF, or OmA or from residuals in model space such as AmF and OmA. In particular the Desroziers approach, the chi-2 and maximum likelihood methods have been used to extract covariance parameters from these residuals. Here we will brush an overview of these methods. We will discuss the convergence of the Desroziers method, and in particular how it fails when error correlation length scale is incorrectly estimated. We will also describe the potential and limitations of the chi-2 method. Finally we will discuss at length about the maximum likelihood method and in particular new results on its simplification for large innovations matrices that leads to an implementable scheme. All these methods and results will be presented in the context of the chemical assimilation scheme.

2C1.6 ID:5659 15:15

Impact of Ill Estimated Error Structures on Ensemble Kalman Filter

Weiguang Chang , *Isztar Zawadzki*
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Error structures of forecast and observation are crucial to Ensemble Kalman Filter (EnKF), but are not exactly known. The forecast error is composed of two parts: the error caused by the uncertainty of model initial conditions, which can be estimated through ensemble forecasts; and model error, which is not yet properly defined. Also, for some observations, such as radar data, their errors are spatially correlated, but the correlation distance is difficult to estimate. In spite of the incomplete error information, one still expects a better analysis by estimating error structures. Therefore, it is beneficial to study the sensitivity of the analysis uncertainty to the accuracy of the error structure estimations.

In this study, analysis uncertainty is defined as the total analysis error variance calculated from the Kalman equations. Simulated observations are assimilated into a two-dimensional background to produce analysis. The impact of ill estimated forecast and observation error covariance matrices on analysis uncertainty is studied by varying the estimates of error variances and correlation distances. The results show that overestimating the observation error correlation is better than underestimating it. Also, underestimating of forecast and observation error variances causes severe problems. Furthermore, the impact of forecast and observation biases on analysis is examined as well.

Nowcasting PART 1 / Prévision immédiate (WAF) PARTIE 1

Room / Endroit (Création), Chair / Président (Stewart Cober), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C2.1 ID:5434 INVITED/INVITÉ 14:00

Challenges of Nowcasting as Learned from SNOW-V10 and CAN-Now

G.a. Isaac [1], *M. Bailey* [1], *F.s. Boudala* [1], *S.g. Cober* [1], *R.w. Crawford* [1], *I. Heckman* [1], *L.x. Huang* [1], *P. Joe* [1], *J. Mailhot* [2], *J.a. Milbrandt* [2], *J. Reid* [1]
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Certain challenges related to Nowcasting have been identified through participation in two projects: the Canadian Airport Nowcasting (CAN-Now) project and the Science of Nowcasting Olympic Weather for Vancouver 2010 (SNOW-V10). These projects were developed for the aviation and sport communities who had very specific requirements. Nowcasting techniques/forecasts must be tuned to their identified users and this talk will emphasize the challenges discovered during CAN-Now and SNOW-V10. These projects have shown the need for high time resolution (every minute) observations and similar temporal scales for NWP data. An NWP model used for Nowcasting needs to be initialized using a high resolution analysis. Selection of model points to represent stations has been a problem for both coarse resolution model (e.g. 15km) and high resolution models (e.g. 1km). NWP model spin up issues can create difficulties. Getting observations that represent specific sites, especially in mountainous terrain is also a problem. Prediction of non standard variables like ceiling, visibility, runway visible range, precipitation type, wind gusts, requires the development and testing of new algorithms. New techniques were required which blend observations and models into nowcast systems and examples will be given in the talk. Verification of nowcasts based on NWP model data alone and the new nowcast systems have yielded some interesting results. For example, it is difficult to forecast relative humidity and this leads to problems related to forecasting visibility. Wind direction forecasts do not verify well. In general, nowcast techniques do show skill when compared to persistence. However, average statistical scores do not always give a good idea of the skill in forecasting high impact events and a further set of performance metrics should be developed and perhaps tuned to specific users.

2C2.2 ID:5570 14:30

Observation of Precipitation and Precipitation Type During the 2010 Winter Olympics in Vancouver and Its Impact on Visibility.

Faisal Boudala , *George Isaac* , *Ismail Gultepe* , *Paul Joe* , *Stewart Cober* , *Ivan Heckman*
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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 forecasting and nowcasting of precipitation is very important. Accurate forecasting and nowcasting of precipitation require accurate determination of precipitation which is necessary for development and validation of the numerical weather prediction, climate models, and satellite and radar remote sensing algorithms. 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 hydrometeors. However, it is usually more complex, particularly at complex terrain because of many factors including wind and evaporation induced loses. There are other kinds of instruments that can measure precipitation such as Hot Plates and scattering probes. These instruments may also suffer from wind and other factors, but they are relatively new and not well tested. 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 including against manual measurements 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.

2C2.3 ID:5599 14:45

Development and testing of a new winter surface precipitation type algorithm at the NOAA/National Severe Storms Laboratory

Heather Reeves
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A new surface precipitation type algorithm that combines thermodynamic profiles from numerical model analyses with polarimetric observations is introduced. The algorithm improves upon existing classification techniques that rely solely on polarimetric radar observations by using thermodynamic information to help diagnose microphysical processes that might occur below the lowest elevation scan. This is especially useful in winter when melting and refreezing occur very close to the ground and, hence, may only be detectable very close to the radar. The algorithm has seven categories of precipitation [hail, rain, snow (wet, dry, or pristine crystals), ice pellets, and freezing rain] and is comprised of a background classification and a radar refinement step. In the background classification, the High Resolution Rapid Refresh native (or sigma) coordinate analyses of wetbulb temperature are used to provide a background classification of precipitation type. Polarimetric radar data are then used to determine whether the background classification is consistent with reflectivity, di erential reflectivity, and the cross-correlation coe cient observations. If an inconsistency is found, the precipitation type is adjusted accordingly. The algorithm output is compared against remote observations of precipitation type collected via the NOAA/National Severe Storms Laboratory - Severe Hazards Analysis Verification Experiment (SHAVE) program. This talk will cover details of the algorithm and the SHAVE program and provide a demonstration of the algorithm performance.

2C2.4 ID:5319 15:00

Real-time Application of a Satellite Based Fog Detection Scheme for Canadian Weather Offices

Victor Kwok Kk Chung , *Ismail Gultepe* , *Janti Reid* , *Guilong Li*
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Fog is a high impact weather event that can affect the public, aviation, and marine communities, resulting in traffic delays and accidents due to reduced visibilities and freezing conditions. Dense fog can be dangerous to aircraft during take off and landing, resulting in unexpected loss of lives and extra financial cost to commercial airlines (Gultepe et al., AMS Bull. 2009). Monitoring of fog in a weather office can be limited because of insufficient observational networks and difficulty in predicting it using current numerical models because of limited parameterization of microphysical processes. Monitoring of fog development usually relies on surface observations and model outputs. To address the issue, a new fog detection scheme was developed by Gultepe et al (2006 and 2007). This scheme uses both GEM Regional model and multi-channel GOES satellite data. The scheme first determines the existence of clouds through a cloud mask test. Then, it determines the presence of fog using the model based surface temperature and relative humidity. The output is simply a “yes” or “no” for fog. These deterministic products were found to improve the real-time monitoring of fog especially in areas where mid and high level clouds do not exist. The satellite based fog detection scheme together with surface and model based parameters can be used to increase the predictability of the fog and visibility. A real-time verification module is also developed and linked to the scheme so that real-time predictability of the fog product can be assessed. In this presentation, several fog cases over central to eastern Canada will be presented to demonstrate the operational applicability of the scheme. The performance, strength, and weakness of the fog detection scheme, future improvements, and its implementation to the newly developed Canadian forecast workstation called NinJo will be summarized.

2C2.5 ID:5382 15:15

ICE FOG (POGONIP) IN ARCTIC DURING FRAM-IF PROJECT

Ismail Gultepe [1], *Thomas Kuhn* [2], *Mike Pavolonis* [3], *Corey Calvert* [4], *James Gurka* [5], *George Isaac* [1], *Stewart Cober* [1], *Peter Liu* [1], *Binbin Zhou* [6], *Randolf Ware* [7], *Brad Ferrier* [6], *Jason Milbrandt* [8]

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The Fog Remote Sensing and Modeling-Ice Fog (FRAM-IF) project took place near Yellowknife International Airport, NWT, Canada during winter 2010-2011 (Nov 25 to Feb 5). Approximately 40 different sensors detected visibility, precipitation and ice particle spectra, as well as vertical thermodynamic profiles and ceiling measured by a microwave profiler (Radiometrics MP-3000A) and ceilometer (Vaisala CL31). Fog coverage and related visibility parameters were estimated using both GOES and MODIS satellite observations.

Ice fog and frost occur commonly (~at least 20% of time) in the northern latitudes and Arctic regions during winter at temperatures (T) less than about -15°C. Ice fog is strongly related to frost formation, a major reason for aircraft deicing in the northern latitudes: in fact, it may be considered as a more dangerous event than snow because of stronger aircraft surface adhesion compared to snow particles. During the project, an inversion layer typically was below 1.5 km height. High humidity typically was close to ground, frequently generating ice fog, frost, diamond dust and light snow precipitation. In this presentation, the project results including detection of small ice crystals (<50 micron) in the ice fog, extinction parameterization, and measurement uncertainties in the northern latitudes will be discussed and new challenges related to ice fog and frost predictions will be presented.

General NWP-WAF PART 3 / NWP WAF en général PARTIE 3

Room / Endroit (Inspiration), Chair / Président (R Bruce Telfeyan), Date (30/05/2012), Time / Heure (14:00 - 15:30)

2C3.1 ID:5336 14:00

A method for improving time-stepping numerics

Paul Williams

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In contemporary numerical simulations of the atmosphere, evidence suggests that time-stepping errors may be a significant component of total model error, on both weather and climate time-scales. This presentation will review the available evidence, and will then suggest a simple but effective method for substantially improving the time-stepping numerics at no extra computational expense.

The most common time-stepping method is the leapfrog scheme combined with the Robert-Asselin (RA) filter. This method is used in the following atmospheric models (and many more): ECHAM, MAECHAM, MM5, CAM, MESO-NH, HIRLAM, KMCM, LIMA, SPEEDY, IGCM, PUMA, COSMO, FSU-GSM, FSU-NRSM, NCEP-GFS, NCEP-RSM, NSEAM, NOGAPS, RAMS, and CCSR/NIES-AGCM. Although the RA filter controls the time-splitting instability in these models, it also introduces non-physical damping and reduces the accuracy.

This presentation proposes a simple modification to the RA filter. The modification has become known as the RAW filter. When used in conjunction with the leapfrog scheme, the RAW filter eliminates the non-physical damping and increases the amplitude accuracy by two orders, yielding third-order accuracy. (The phase accuracy remains second-order.) The RAW filter can easily be incorporated into existing models, typically via the insertion of just a single line of code. Better simulations are obtained at no extra computational expense.

Results will be shown from recent implementations of the RAW filter in various atmospheric models, including SPEEDY and COSMO. For example, in SPEEDY, the skill of weather forecasts is found to be significantly improved. In particular, in tropical surface pressure predictions, five-day forecasts made using the RAW filter have approximately the same skill as four-day forecasts made using the RA filter. These improvements are encouraging for the use of the RAW filter in other models.

2C3.2 ID:5456 14:15

The New 10km-4DVAR Canadian Regional Deterministic Prediction System

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The newly developed 10km-4DVAR Regional Deterministic Prediction System (RDPS) is presented.

This system, executed 4 times a day (00, 06, 12 and 18UTC), is used at the Canadian Meteorological Center for short range Numerical Weather Prediction (48 hrs) over North America.

The improved RDPS, expected to become operational in June 2012, replaces the current 15km-3DVAR system.

While a companion paper (Luc Fillion) presents the improvements to the assimilation system, this presentation focuses on the improvements to the model itself.

These include an increase in resolution from 15 to 10 km, changes to the vertical diffusion scheme, as well as several modifications which have a significant impact on surface fluxes, on water in particular.

It will be shown that the new system significantly reduces the rms errors in winds, temperature and geopotential height throughout most of the troposphere both in winter and in summer.

It will also be shown that improvements can be expected in freezing rain situations where the current RDPS tends to miss or underestimate freezing rain because of over active vertical diffusion.

2C3.3 ID:5756 14:30

Sensitivity of Hurricane Forecasts to Boundary Layer Turbulence Parameterization

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Recent studies based on numerical simulations of an idealized hurricane have revealed that hurricane intensity and structure are highly sensitive to horizontal turbulence length scale in the turbulence parameterization scheme. In this study, this sensitivity is investigated using real case simulations. Numerical forecasts of Category 4 Hurricane Earl (2010) using Weather Research and Forecasting (WRF) model with varying horizontal resolutions and turbulence length scale were conducted. It is found that the turbulence length scale has much larger impact on the intensity than the model resolution. Choosing a turbulence length scale of about 1000m as suggested by other studies only produces a weak Category 3 storm. Not only the structures of Earl change significantly, but also the large scale environment and the evolutions of the downstream Hurricane Danielle and upstream Tropical Storm Fiona are dramatically different. These results again indicate proper turbulence parameterization scheme is essential for successful hurricane predictions.

2C3.4 ID:5653 14:45

Predicting the Density of Graupel in a Bulk Microphysics Scheme

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Microphysics schemes generally suffer from the need to specify a constant density and terminal fall velocity parameters for the various hydrometeor categories. This is especially problematic for categories such as graupel, whose real range of densities and fall velocities varies considerably. A method is described to modify a two-moment bulk scheme by adding a prognostic equation for the bulk graupel volume mixing ratio which, along with the prognostic mass mixing ratio and number concentration, allows for the bulk density to be a predicted quantity, variable in time and space. Changes to the volume mixing ratio are determined through physically-based changes to the graupel density from various microphysical processes including riming, which is based on a parameterization of rime density from laboratory measurements. The graupel density in turn affect the terminal fall velocity parameters, whose values are now determined diagnostically, and which result in a realistically wide range of fall speeds.

Results will be presented using 3D mesoscale model simulations of cases of deep convection and of winter snowstorms. It will be shown that the use of a variable graupel density in the microphysics scheme results in a realistic representation of the full range of graupel types, from lightly rimed crystals to high-density hail, and with little sensitivity to thresholds used to determine the transition between categories. Also, a method will be proposed by which a variable graupel density can be incorporated into a two-moment scheme without the need for any additional prognostic variables.

2C3.5 ID:5507 15:00

Seasonal Precipitation Downscaling from NCEP Climate Forecast System Prediction with WRF Model and an Analog Algorithm

Wanli Wu [1], *Yubao Liu* [1], *Ming Ge* [1], *Dorita Rostkier-Edelstein* [2], *Gael Descobes* [1], *Pavel Kunin* [2], *Scott Swerdlin* [1], *Amir Givati* [3], *Thomas Hopson* [1]

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Ensemble-based probabilistic seasonal forecasts at leading numerical weather prediction centers like NCEP have become more accurate and reliable. Seasonal forecasts are increasingly used in a range of applications to improve weather-critical risk managements. However, global forecasting models like the Climate Forecast System (CFS) at NCEP cannot provide detailed forecasts at regional and local scales demanded by weather sensitive agencies due to their coarse resolutions. To bridge the gaps between the global model seasonal forecasts and regional and local needs, in this study, an integrated downscaling system combining an analog statistical downscaling algorithm, K-nearest neighbors (KNN), and WRF modeling system, is developed to produce seasonal precipitation forecasts at fine scale with 2-4 months lead-time for the Eastern Mediterranean, a semi-arid region that is sensitive to water supply. Specifically, the downscaling system, driven by the CFS operational forecast and reanalysis, provides monthly and seasonal precipitation for the area that represents the major basins for supporting local water resource management. Besides a single deterministic forecast, this study constructs sixty ensemble members based on the available CFS ensemble members to generate probabilistic forecasts. The downscaled predictions show fine-scale information, such as fine scale spatial variability, which is important for regional and local water resource management. The verification against observations shows significantly improved skills in this downscaling utility relative to the global CFS model. The seasonal precipitation downscaling utility is now running operationally by the Israel Water Authority to drive hydrologic models estimating river flow and aquifer charge for planning of water supply.

Unified modelling systems for weather and climate / Système de modélisation météorologique et climatologique unifié (NWP)

Room / Endroit (Grand salon A), Chair / Président (Martin Charron), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E3.1 ID:5363 INVITED/INVITÉ 16:30

Seamless prediction in practice: experiences at the Met Office

Andrew Brown

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In recent years there has been a growing appreciation of the potential advantages of using a seamless approach to weather and climate prediction. However, what exactly should this mean in practice? To help address this question, this presentation will document some of the experiences already gathered over 25 years of developing and using the Unified Model at the Met Office for both weather and climate prediction.

Overall, we believe that taking a unified approach has given enormous benefits. These are both scientific and in terms of efficiency and, based on this experience, our approach has been gradually evolving to be more seamless. However some of the challenges in working in a unified prediction framework will also be discussed.

2E3.2 ID:5791 17:00

A numerical research laboratory for the observation and modeling of the Earth system

Pierre Gauthier [1], *M.k. Yau* [2], *Michel Bourqui* [2], *René Laprise* [1], *Laxmi Sushama* [1], *Julie Thériault* [1]

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An atmospheric model is only representing our current understanding of the physical processes at work and its results must be compared with respect to the available observations of the atmosphere, ocean and every component that makes up the Earth system. Observations are provided by the global observation network that support meteorological forecasts and also, by numerous satellite research instruments. Data assimilation provides the bridge between modeling and observation and is the validation stage of any numerical model, the laboratory where the theory (the model) is confronted to measurements (the global observing network). The gain obtained in the quality of operational weather forecasts comes from the fact that the development of the model is done in conjunction with its validation through the efforts in the data assimilation process which is needed in academic research as well to compare the model to observations. It is through this process that we can improve our understanding of the complexities of the interactions taking place within the atmosphere and the Earth system.

High performance computing (HPC) is needed to make advances in that direction. In Canada, academic research benefits from significant computing resources provided by Compute Canada. A resource allocation has been granted to a group of researchers from McGill University and Université du Québec à Montréal (UQAM) to support atmospheric modeling and data assimilation for regional climate studies (Sushama, Laprise), high resolution simulations of the formation and evolution of hurricanes (Yau), climate studies and atmospheric chemistry (Bourqui), impact of physical processes (Thériault) and data assimilation applied to coupled ocean-atmosphere models and impact studies of the global observation network (Gauthier). Several presentations at the Congress cover the outcomes of this initiative. This presentation will focus on the value for any modeling effort to be carried out in conjunction with a companion data assimilation effort.

2E3.3 ID:5361 17:15

The NCEP’s Nonhydrostatic Multiscale Atmospheric Model NMMB

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A new fully compressible unified Nonhydrostatic Multiscale Model (NMMB) is being developed at the National Centers for Environmental Prediction (NCEP). The model has been designed for a broad range of spatial and temporal scales; from meso to global, and from short range weather forecasting to climate studies. The latitude-longitude grid is used for the global domain, and rotated latitude-longitude coordinate is employed for regional applications. A general, pressure-based terrain following vertical coordinate is applied. Quadratic conservative horizontal differencing conserves a variety of first order and quadratic quantities and preserves some important properties of differential operators. The conservation of energy and enstrophy improves the accuracy of nonlinear dynamics. The polar filter selectively slows down wave components of the basic dynamical variables. In very high-resolution tests the model successfully reproduced classical two-dimensional nonhydrostatic solutions. In regional short range runs, the model dynamics demonstrated the ability to develop the –3 and –5/3 spectral slopes with realistic transition between the two. These properties of the spectra are not induced by computational noise and maintained by numerical filters. In a decaying turbulence case on convective scales, the model developed the –5/3 spectrum. A global forecasting system based on the NMMB has been run for more than two years in order to test and tune the model. The skill of the medium range forecasts produced was comparable to that of other major systems. The regional NMMB replaced the WRF NMM at NCEP as the North American Model (NAM) and in a number of nested runs. The problem of application of deep moist convection parameterization with single digit resolutions has been addressed using the Betts-Miller-Janjic (BMJ) scheme. Being an adjustment scheme with proper asymptotic behavior, the application of the BMJ scheme at very high, single digit resolutions is not in conflict with the basic parameterization assumptions.

2E3.4 ID:5556 17:30

The Korea Institute of Atmospheric Prediction Systems - KIAPS: Its Birth, Plans and Progress

Young-Joon Kim , *Emilia Kyung Jin* , *Dongchan Joo* , *Shinhoo Kang* , *Junghan Kim* , *So-Young Kim* , *Hataek Kwon* , *Jihye Kwun* , *Tae-Jin Oh* , *Hyo-Jong Song* , *In-Sun Song*
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The Korea Meteorological Administration (KMA) has been producing numerical weather forecast products for Korean peninsula and surrounding areas since 1991. KMA has been using numerical weather prediction (NWP) models based on the systems developed by Japan in the past and currently UK. In order to cope with rapidly-changing environment and improve weather forecast of the Korean peninsula, KMA proposed a 9-year project to develop Korea's own NWP system and obtained funding of about 100 million US dollars in total. To achieve the goal, in 2011 the Korea Institute of Atmospheric Prediction Systems (KIAPS; formerly, the Next Generation Model Development Center) was founded by KMA in the form of a non-profit foundation. The objectives of the project are expanded to the stimulation of the research and development efforts of the Korean NWP community, the reduction of the astronomical economic loss caused by weather-related disasters, and also the enhancement of the industrial sector productivity with improved weather predictability. The eventual goal is to become competitive and actively participate in the international operational NWP community by developing original technologies and seeking international collaboration. The project will consist of three phases, each of which is 3-years long. The first phase is a preparatory stage, first to establish the Institute and then lay out plans, hire researchers, design the basic structure, and explore/develop core technologies. The second phase will aim at building a prototype NWP system by developing the modules for the dynamical core, physics packages and data assimilation systems. The third phase is for testing and finalizing the operational system by evaluating and selecting modules as well as by developing pre- and post-processing systems. In 2012, we will be developing key modules for the dynamical core by adopting and further developing new cores being developed elsewhere, and also developing and testing barotropic models with code parallelization in mind. We will be collecting various physical parameterization schemes, mostly developed by Korean scientists, and evaluating them by using single-column and LES models. We will be designing control variables for variational data assimilation systems, constructing testbeds for observational data quality control systems, developing linear models for a barotropic system, designing modules for cost function minimization. We will be developing the model framework with flexibility in imported and exported variables, designing the I/O structure of the system, and

coupling modules for external systems. We will also start developing post-processing systems. In addition, we are planning to actively seek collaborations with both domestic and foreign entities and establish international network by forming advisory boards and hosting international workshops and symposiums. At the conference, we will introduce KIAPS and present its progress in the research and development efforts. We cordially invite NWP community members to witness the inauguration of a new NWP center, which we hope will take part in the global NWP business.

2E3.5 ID:5700 17:45

Formulation and testing of a mass-conserving semi-implicit semi-Lagrangian model using the continuity equation in its flux-divergence form

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(Presented by *May Wong*)
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Semi-implicit semi-Lagrangian (SLSI) models are popular for both global and regional numerical weather prediction (NWP) applications primarily due to their stability and computational efficiency with larger time steps. Many existing SLSI models solve the mass continuity equation in its velocity divergence form, making mass conservation more difficult and forgoing consistency between mass and scalar mass transport. While several recently developed cell-integrated semi-Lagrangian (CISL) transport schemes exist that evaluate the mass continuity equation in an inherently mass-conserving manner, semi-implicit fluid-flow solvers using these CISL schemes have relied on a velocity-divergence correction in the continuity equation, thus excluding the possibility of consistency between mass and scalar-mass transport. Here, we test a new mass conserving semi-implicit semi-Lagrangian shallow-water equations model that solves the continuity equation in its flux-divergence form. The proposed solver uses the Conservative Semi-LAgrangian Multi-tracer scheme (CSLAM; a CISL approach) as the transport scheme and uses it to evaluate the flux-divergence term in the continuity equation. We derive an exact formulation of the Lagrangian flux divergence in its Eulerian form, and cast the implicit correction as an Eulerian mass divergence, for use in the solver. We test the new formulation in a 2D shallow-water model and compare simulation results with those produced from solvers using existing formulations. The results show that the new scheme is stable and its solutions compare well with those produced using other formulations. Our new approach using CSLAM can be extended to a fully compressible nonhydrostatic semi-Largrangian solver providing exact conservation and consistency for mass and scalar mass transport.

Regional Climate Modelling and Climate Projections PART 3 / Modélisation du climat régional et projections du climat PARTIE 3

Room / Endroit (Symphonie 2), Chair / Président (Laxmi Sushama), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E6.1 ID:5300 INVITED/INVITÉ 16:30

Diagnosing Future Projections of Permafrost

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Permafrost plays a significant role in many physical processes across the terrestrial Arctic. Recently, ground temperatures have increased and active layers deepened in many regions, thus posing questions about the future fate of near-surface permafrost (i.e. the upper 3.5m of the ground). Permafrost extent in GCMs and RCMs is a function of the surface climate of the model as well as the ability of the land model to simulate permafrost for a given climate. We separate these two effects by using an indirect estimator of permafrost that is driven purely by climatic indices from each CMIP5 model and compare it to permafrost extent directly diagnosed from soil temperatures. Robust conclusions that can be drawn from our analysis are: (a) CMIP5 models contain climate biases which can impact their future trajectory of permafrost area. Over the present day permafrost region half of the models have a cold bias of -0.5C or more for 1986-2005. Normalized mean winter snow depth over this region varies across models from 0.21m to 0.44m. Such biases need to be accounted for when making regional projections. (b) The response of diagnosed permafrost area in land models, relative to climate forcing, is consistent under all RCP warming scenarios for all CMIP5 models. However, the rate of permafrost decline in individual land models relative to surface climate change varies widely, thus indicating that land model structure plays a significant role. (c) Under the RCP8.5 scenario, direct and indirect diagnoses indicate that at year 2100, permafrost is unlikely to be sustainable over almost all Alaska, but permafrost will probably persist north of 71N, across the majority of the Canadian Archipelago, portions of the East Siberian uplands and parts of the Tibetan plateau.

2E6.2 ID:5454 17:00

Sensitivity of Canadian RCM simulated surface/sub-surface climate for the pan- Arctic region to soil model configuration and organic matter

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Many climate modeling groups have realized the importance of deeper soil configuration and representation of soil organic matter for realistic simulation of surface and sub-surface climate in the high latitudes. Previous studies have showed large sensitivity of the simulated near-surface permafrost extent to implementation of soil organic matter in climate models. Decreased thermal conductivity combined with increased porosity and water content associated with the presence of soil organic matter tends to lower soil temperature at high latitudes, which leads to better representation of near-surface permafrost extent within climate models.

This study performed with the fifth generation of the Canadian Regional Climate Model (CRCM5) using deep and shallow configurations of the land surface scheme CLASS3.5 (Canadian LAnd Surface Scheme) evaluates the sensitivity of land-atmosphere fluxes, surface and sub-surface thermal and moisture regimes, to presence of soil organic matter and to the depth of the soil model over a pan- Arctic domain, which includes the continuous, discontinuous, sporadic and isolated permafrost zones.

2E6.3 ID:5574 17:15

Comparison of composite and mosaic approaches of land-surface heterogeneity representation in CRCM5

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Realistic representation of subgrid variability is important in a land surface model for better simulation of the energy and water partitioning at the surface. The land surface scheme used in the fifth generation of the Canadian RCM (CRCM5) is the latest version of the CAnadian Land Surface Scheme (CLASS3.5), which supports mosaic formulation. With the mosaic approach, the different vegetation types in a grid are viewed as separate tiles of a grid mosaic, and fluxes are computed for each of these tiles separately, and the average of these is passed to the atmosphere. With the composite approach, fluxes are computed using averaged vegetation attributes and then passed to the atmosphere. Three pairs of 10-year long simulations are performed with CRCM5, at 100 km, 45 km and 15 km resolution, respectively, driven by ERA-Interim data at the boundaries. The two simulations in each of the three pairs correspond to composite and mosaic representation of vegetation, respectively, in the model. In this paper, the near surface variables (turbulent and radiative fluxes, temperature etc.) from the composite/mosaic simulations will be compared to those observed and the impact of mosaic vs. composite formulation at different resolutions discussed.

2E6.4 ID:5757 17:30

Projections of climate change impacts in the Arctic Ocean

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To construct an ensemble of high-resolution regional climate change projections of atmospheric forcing over the Arctic Ocean during 1970-2069, we will use CRCM (Canadian Regional Climate Model) to dynamically downscale atmospheric driver fields, for a pan-Arctic domain (45km resolution) from the CCCma coupled global climate model (CGCM3) outputs for the A1B IPCC climate change scenario. The domain is almost the entire Arctic (to the northern part of the North Atlantic) and a large area of northern North America. The simulation is for 100 years, and comparisons involve present climate, 1970-1999, and future climate 2040-2069. We include fresh water river run-off effects in continental shelf areas, for example by preparing downscaled atmospheric/hydrological fields involved in the basin projections (e.g. Mackenzie Delta and drainage area, including Great Slave and Great Bear Lakes) and Russian rivers from CRCM outputs. We use CRCM to drive a state-of-the-art DFO coupled ocean-ice model (CIOM). This model was used extensively in DFO during IPY. For validation of CRCM outputs, we do comparisons using climate reanalysis data, such as NCEP, CFSR, etc., as well as NARCCAP and CORDEX data, as needed for validation of present climate conditions, and comparisons with radioactive iodine tracer data, which circulate in Arctic waters, having drifted from reprocessing plants in England and France. We estimate ice-ocean trends and projections for the Beaufort- Chuckchi Seas region in west Canadian Arctic for 1970-2069. We show trends for Arctic ocean warming by ~ 2-4 degrees, decrease in ice volume, and thickness but still present in summers, indications of more west Arctic storms, or perhaps fewer or more intense west Arctic storms, less in the east Arctic, Beaufort gyre intensification with increased fresh water content, and consistently, increased saltiness in the east Arctic, increased freshening in the west Arctic.

Climate Change and Extreme Events PART 2 /

Changements climatiques et événements extrêmes PARTIE 2

Room / Endroit (Symphonie 3A), Chair / Président (William Hsieh, sponsored by / commantitée par A-O , T&F), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E7.1 ID:5488 16:30

Simulated winter cyclone event frequencies from the "AMIP-type" experiments performed using CMIP5 models

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"AMIP-type" experiments are simulations by models which are forced by observed sea surface temperatures and sea-ice extent. The AMIP simulations by CMIP5 models are analyzed for winter cyclone events defined as local minima in the Mean Sea Level (MSL) Pressure field. The simulated events are accumulated poleward of 30N and 30S degrees in both hemispheres using daily mean MSL pressures for the period January 1979 to December 2008. The nine-year northern hemisphere winter (DJF) mean and the ten-year southern hemisphere winter (JJA) mean averaged over all available models are presented and compared to the observed winter means based on the ERA-Interim analyses.

In the northern hemisphere, the interannual variability of the simulated events is evaluated by examining the temporal correlations of the simulated seasonal events with the observered seasonal events. Only those events with a central pressure less than 975 mb over the Pacific Ocean are considered. A corresponding evaluation is made for the southern hemisphere using all events poleward of 30N with a central pressure less than 965 mb.

The strengths and weaknesses of the individual models and the model mean will be discussed.

2E7.2 ID:5692 16:45

Application of artificial neural networks on North Atlantic tropical cyclogenesis potential index in climate change

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(Presented by *Zheng Yip*)
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A methodology using artificial neural networks is presented to project 21st century changes in North Atlantic tropical cyclone (TC) genesis potential (GP) in a ten-model ensemble of global climate models (GCMs). Two types of neural networks – the self-organizing maps (SOMs) and the back- propagating neural networks (FBNN) were employed. This methodology is demonstrated to be a robust alternative to using GCM output directly for tropical cyclone projections, which generally require high-resolution simulations. By attributing the projected changes to the related environmental variables, we used Emanuel’s revised Genesis Potential Index to measure the GP. Changes are identified in the 1st (P1) and 2nd (P2) half of the 21st century. The peak summer GP over the region of frequent TC genesis is projected to decrease more substantially in P1 than in P2. Vertical wind shear (850-200hPa), temperature (600hPa), and potential intensity are the most important controls of TC genesis in the NAB under our changing climate. Since there are several other tropical cyclone genesis indexes developed in the recent years (e.g. Emanuel revised GPI (2010); Tippett et

al. (2011)), a comparison of these indexes to the one employed in this study will also be presented.

2E7.3 ID:5314 17:00

An Assessment of Canadian Prairie Drought: Past, Present, and Future

Barrie Bonsal [1], *Rabah Aider* [1], *Philippe Gachon* [1], *Suzan Lapp* [2]

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Droughts are one of the most dramatic manifestations of extremes in the water cycle. Prolonged, large-area droughts are among the world's costliest natural disasters having major impacts on agriculture, forestry, industry, municipalities, recreation, human health and society, and aquatic ecosystems. Within Canada, the Canadian Prairies are particularly drought-prone mainly due to their location in the lee of the western cordillera. Although previous studies examined the occurrence of Canadian Prairie droughts during instrumental, pre-instrumental and to a lesser extent, future periods, none have specifically focused on their trends and variability over all three scales. Using the Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) as drought indicators, this investigation assesses the variability of summer drought occurrence over a core region of the Canadian Prairies during a) the pre-instrumental record extending back several centuries (as inferred from tree rings), b) the instrumental record (1901-2005), and c) the 21st century as projected by several Global Climate Models with multiple emission scenarios. Results show that pre-instrumental droughts were generally more prolonged and severe than those during the 20th century. Projected changes to future droughts differ between the two drought indicators. The PDSI suggests increases in drought frequency and in some cases, severity particularly, after 2050. Conversely, SPI generally shows no significant changes to future drought frequency over the region. All future scenarios for PDSI and SPI do, however, suggest increased variability in drought-related extremes. This study can be considered an initial step toward quantifying and understanding Canadian Prairie drought occurrence over several centuries as determined from paleo, instrumental, and climate model data sources.

2E7.4 ID:5294 17:15

Canadian RCM projected changes to high flows for Québec watersheds using regional frequency analysis

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Information related to changes in streamflow characteristics is important in the management and future planning of various water resource related projects in the context of a changing climate. In this study, projected changes to selected return levels of high flows for 21 watersheds, located mainly in the Québec province of Canada, are assessed following Regional Frequency Analysis (RFA). This assessment is based on a ten-member ensemble of Canadian Regional Climate Model (CRCM) transient climate change simulations, of which five correspond to current 1970–99 period and the remaining five are the matching simulations for the future 2041–70 period. The RFA approach adopted in this study allows better estimation of return levels, particularly for higher return periods. Furthermore, this is the first comprehensive study on high flow characteristics covering the entire 21 watersheds for the region in the context of a changing climate. Results of ensemble averaged projected changes to regional return levels show increases for most of the watersheds. In particular, changes to 5- and 10-yr (compared to 30- and 50-yr) regional return levels are found statistically significant more often for northern watersheds compared to the rest. An analysis of confidence in projected changes to selected regional return levels, based on five current/future period

simulation pairs, reveal a higher level of confidence for northern watersheds. When regional level projected changes are downscaled to CRCM grid-cell-level, a pattern similar to that for regional level changes is noticed, though with slightly increased range of changes. The results of the study have important implications for water resources management and reservoir operating policies in this region of Canada.

2E7.5 ID:5777 17:30

Possible Impacts of Climate Change on Future Hourly/Daily Wind Gust and Extremes at Local scale over Canada

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The overarching purpose of this study was to project changes in the frequency and intensity of future hourly/daily wind gust events under downscaled future climate conditions over Canada. Wind gust factors were employed to simulate hourly/daily wind gusts based on observed hourly/daily wind speed. Regression-based downscaling methods were used to downscale future hourly/daily wind speed to each of the selected cities over Canada for eight GCM models with IPCC SRES A2 and B1 scenarios. The wind gust simulation models were then applied using downscaled future GCM wind speed data to project changes in the frequency and intensity of future hourly/daily wind gust events. Downscaling transfer functions and wind gust simulation models were validated using a cross-validation scheme and comparing data distributions and extreme-event frequencies derived from both downscaled GCM historical runs and observations over a comparative time period 1961–2000. The results of the verification, based on historical observations of the outcome variables simulated by the models, showed a very good agreement. By comparing the current-past observed conditions, the frequency and intensity of future hourly/daily wind gust events in the study area are projected to significantly increase under a changing climate late this century.

This talk will introduce the research project and outline the modeling exercise and verification process. The major findings on future wind gust projections from the study will be summarized in the presentation as well. One of the major conclusions from the study is that the procedures used in the study are useful for climate change impact analysis on future hourly/daily wind gusts and extremes. The implication of the significant increases in future wind gust risks should be taken into consideration when revising engineering infrastructure design standards and developing adaptation strategies and policies.

2E7.6 ID:5751 17:45

A New Potential Measurement Technique for Hurricanes: Cross-Polarized Synthetic Aperture Radar

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We present an empirical C-band Cross-Polarization Ocean backscatter (C-2PO) model for wind retrievals, from synthetic aperture radar (SAR) data collected by the RADARSAT-2 satellite. The C-2PO model relates normalized radar cross section (NRCS) in cross-polarization (VH) to wind speed at 10-m height. This wind retrieval model has the characteristic that it is independent of wind direction and radar incidence angle but is quite linear with respect to wind speed. To evaluate the accuracy of the proposed model, winds with resolution on the scale of 1 km were retrieved from a dual-polarization SAR image of Hurricane Earl on September 2, 2010, using the C-2PO model and compared with CMOD5.N, the newest available C-band geophysical model function (GMF), and validated with collocated airborne Stepped Frequency Microwave

Radiometer (SFMR) measurements and National Data Buoy Center (NDBC) data. Results suggest that for winds up to 38 m/s, C-2PO has a bias of -0.89 m/s and a root mean square (RMS) error of 3.23 m/s, compared to CMOD5.N, with bias of -4.14 m/s and RMS difference of 6.24 m/s. Similar results are obtained from Hurricane Ike, comparing wind retrievals from C-2PO and CMOD5.N with H*Wind data. The advantage of C-2PO over CMOD5.N and other GMFs is that it does not need any external wind direction and radar incidence angle inputs. Moreover, in the presently available quad-polarization dataset, C-2PO has the feature that the cross-polarized NRCS linearly increases even for wind speeds up to 26 m/s, and reproduces the hurricane eye structure well, thereby providing a potential technique for hurricane observations from space.

Communicating uncertainty in weather forecasting and NWP (WAF) / Communiquer l'incertitude en prévision météorologique (WAF)

Room / Endroit (Symphonie 4), Chair / Président (Philippe Gachon), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E4.1 ID:5477 16:30

Probabilistic Verification of Global and Mesoscale Ensemble Forecasts of Tropical Cyclogenesis

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As part of the NSF PREDICT project, ensemble-based products have been developed with a goal to improve improved probabilistic predictions and also our quantitative understanding of the predictability of tropical cyclogenesis. The probabilistic verification of quantities based on global (ECMWF) and regional (WRF-ARW) ensemble forecasts will be presented for the 2010 and 2011 Atlantic Hurricane seasons. Threshold values of common metrics including a low-layer average circulation, a local thickness anomaly, and the rates of change of these quantities, are used to determine the onset of cyclogenesis in the models. In addition to evaluating these quantities that describe the developing tropical cyclone, probabilistic evaluations will also be performed for relevant environmental characteristics such as vertical wind shear. These evaluations will help identify errors and biases in probability distributions, and improvements to ensemble prediction schemes will be suggested.

2E4.2 ID:5697 16:45

Uncertainty Analysis of MDCRS Derived Crosswind for Wake Turbulence Mitigation Application

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An uncertainty analysis on the Meteorological Data Collection and Reporting System (MDCRS) data for the purpose of wake turbulence mitigation application has been carried out. MDCRS data are widely available around US airport proximity, containing meteorological information along the aircraft path. Collocated sensors opportunity exists to validate MDCRS wind against the Light Detection and Ranging (LIDAR) Velocity Azimuth Display (VAD) wind information from five US airports where the Federal Aviation Administration has conducted the wake turbulence avoidance data collection effort. The LIDAR system used in the FAA effort is the 2µm Lockheed Martin WindTracers. The advantage of comparing winds against a high resolution LIDAR wind instrument helps better quantify the uncertainty of MDCRS wind measurements. This characterization is important for a number of reasons, from devising wake turbulence procedures to design of a forecast system for wake mitigation. Over the past nine years, from 2003 to 2011, LIDAR VAD weather data across five US international airports from coast to coast, have been used for this comparison with the MDCRS. The focus on crosswind component of the total wind is motivated by the current emphasis on developing crosswind based wake mitigation solutions. Based on the weather analysis from five airports, crosswind uncertainty is quantified by altitude up to 3,000ft for each sensor - MDCRS or LIDAR.

2E4.3 ID:5850 17:00

Utilizing Ensemble Forecasting in the Prairie and Arctic Storm Prediction Center

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In 2011, the Prairie and Arctic Storm Prediction Center (PASPC) in Winnipeg, Manitoba began a pilot project to encourage the greater use of ensemble products in an operational setting. With a large area of responsibility encompassing much of western and northern Canada, the PASPC faces unique challenges in balancing heavy workloads and timely hazardous weather forecasting with the diverse array of information available to the forecaster. Model data from the North American Ensemble Forecast System (NAEFS) was used as a starting point for visualizing new ensemble products better tailored to the day-to-day needs of PASPC operations. Derived forecast fields for all seasons, specialized data clustering, and aggregation of multiple ensemble runs were each investigated as a means to this end. In this presentation, the purpose and utility of these new output products are discussed, emphasizing both reactions from operational forecasters as well as objective verification scores spanning the course of an entire year.

2E4.4 ID:5462 17:15

The 2012 HMT-HPC Winter Weather Experiment

Faye Barthold [1], *David Novak* [2], *Michael Bodner* [2], *Thomas Workoff* [3], *Dan Petersen* [2], *Richard Otto* [2], *Michael Musher* [2], *Richard Bann* [2], *Andrew Orrison* [2], *Jun Du* [4], *Scott Rentschler* [5]
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The Hydrometeorological Testbed at NCEP's Hydrometeorological Prediction Center (HMT-HPC) hosted its second annual Winter Weather Experiment from 9 January to 10 February 2012. This year's experiment

focused on using ensemble systems to help quantify and communicate uncertainty in winter weather forecasts. Over the course of the five week experiment, 21 forecasters, researchers, and model developers used a combination of operational and experimental ensemble output to forecast the probability of exceeding 2 in, 4 in, and 8 in of snowfall over a 24 h period. The experimental ensemble guidance included a new version of NCEP's Short Range Ensemble Forecast system (SREF) as well as a 10-member 4 km convection allowing ensemble provided by the Air Force Weather Agency (AFWA). In addition, participants explored the utility of several new diagnostics such as ensemble clusters and plots of model trend reversals.

In addition to issuing experimental probability of exceedance forecasts, participants were also asked to consider their overall level of forecast confidence. This information was then conveyed through a written forecast confidence discussion that detailed the group's confidence in event timing, location, snowfall amounts, and precipitation type. The experiment also featured a societal impacts scenario in which participants were asked to prepare a mock briefing for a non-meteorological decision maker about the upcoming winter weather event.

This presentation will provide an overview of the Winter Weather Experiment, show preliminary subjective verification results, and highlight lessons learned about communicating uncertainty in winter weather forecasts.

2E4.5 ID:5657 17:30

The status of the FNMOC Ensemble Forecast System

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The current status and planned future directions of the FNMOC Ensemble Forecasting System, heretofore FNMOC EFS, will be discussed. One of the highest priorities of the FNMOC mission statement is to assist the naval forces around the globe, and dissemination of useful and relevant FNMOC EFS data poses significant challenges. At present, a rotating 20-member suite of NOGAPS members initialized by an Ensemble Transform method at a resolution of T159L42 is run twice a day – 00Z and 12Z – and stored as 1-degree by 1-degree gridded data. There are current plans to improve the resolution of the FNMOC EFS to T239 and for the possible switch in the near-term to the next-generation Navy model (NAVGEM). Currently, there are post-processed static images on FNMOC's WxMap display web page and raw data available on the Navy's data distribution systems – CAGIPS and METCAST. Future products include bias-corrected (Cui et al, in press.) ensemble members as part of the NUOPC project, on-demand customizable ensemble products – including but not limited to probabilities and plume plots – from the proprietary CAGIPS and METCAST systems, and twice-daily verification of the system against both observations and gridded analyses.

DA IV: Assimilation of Observations / Assimilation des observations

Room / Endroit (Ovation), Chair / Président (Zhaoxia Pu), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E1.1 ID:5686 INVITED/INVITÉ 16:30

Development and testing of storm-scale radar-data-assimilation and forecasting systems

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Radar-data assimilation has the potential to improve high-resolution numerical weather prediction (NWP) of convective storms, but a number of challenges must be overcome. First, national radar networks collect enormous datasets every minute, making it difficult to obtain, process, and assimilate the data quickly enough to produce a timely forecast. Second, since most model variables are unobserved on small scales, radar-data assimilation involves retrieving unobserved fields in situations with highly flow-dependent background-error covariances.

Accepting these challenges, we are developing and testing radar-data- assimilation methods for both the current and next generation of NWP. For NOAA's High Resolution Rapid Refresh (HRRR) model, an hourly-updated implementation of the Advanced Research Weather and Forecasting (WRF- ARW) model with 3-km horizontal grid spacing, we are evaluating forecasts initialized with radar reflectivity, augmenting the diabatic digital filter initialization with reflectivity data already in the 13-km parent model (Rapid Refresh). Microphysical temperature tendency information on the HRRR 3-km grid is provided by latent heating fields estimated from reflectivity data at 15-min intervals during a 1-h assimilation window. This initialization method is a candidate for real-time implementation this year.

For the next generation of high-resolution NWP, NOAA's Warn-on-Forecast project is evaluating ensemble forecasting and advanced methods for assimilating Doppler-velocity and reflectivity observations, for the purpose of improving 0-6 h predictions of convective storms. We are currently testing ensemble Kalman filter (EnKF) methods for initializing ensemble retrospective forecasts of severe weather outbreaks.

At the conference, we will report on both the current-generation (latent- heating specification in the HRRR) and next-generation (EnKF) methods for storm-scale radar-data assimilation and forecasting. Retrospective forecasts initialized with the two methods provide the opportunity to evaluate tradeoffs of computational requirements and forecast skill.

2E1.2 ID:5619 17:00

Preparing radar information for its proper assimilation: The Devil is in the details

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Data assimilation techniques try to optimally blend information from multiple sources of information. As a result, best success will be obtained if all of the following conditions are met:
1) Data are unbiased;
2 Observation operators that allow the model to simulate observations are accurate;
3) Errors and their spatio-temporal correlation structure are well described.
Yet, I am not aware of a single data assimilation experiment where all three conditions were met. In an attempt to improve radar data assimilation, we have embarked in a multi-pronged effort:

A) *Data cleaning for assimilation use*: Using dual-polarization spectral information, we have improved the way we isolate ground targets. In parallel, we have a separate stream for data cleaning for data assimilation purposes (no tolerance for bias, even if it means data gaps) in addition to the more traditional one for forecaster use (limited tolerance to data gaps, more willing to accept imperfect data);
B) *Better observation operators*: Properly simulating reflectivity and Doppler velocity observations from model data in an efficient manner is not as easy as it sounds. We have developed full observation operators for radial velocity and found them unusable, which led to the design of the best possible simplifications for real-time uses;
C) *A first attempt at establishing and coding the error correlation structure*: Even with a perfect observation operator, the correlation structure of radar errors is far from simple and has considerable non-trivial radial and azimuthal structures. Examples of these will first be presented that will set constraints on how the correlation structure of radar errors should be expressed.

2E1.3 ID:5710 17:15

Enhancements to the Gridpoint Statistical Interpolation cloud analysis and rawinsonde assimilation for the second version of the Rapid Refresh

Patrick Hofmann [1], *Ming Hu* [1], *Stanley Benjamin* [2], *Stephen Weygandt* [2], *Curtis Alexander* [1]
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The Rapid Refresh (RAP) is an hourly updated mesoscale analysis and prediction system developed by the NOAA Earth System Research Laboratory (ESRL) Assimilation and Modeling Branch (AMB) for aviation, severe weather and general forecast guidance. The RAP is in final testing at the National Centers for Environmental Prediction (NCEP) to replace the Rapid Update Cycle (RUC), with a planned operational implementation of March 2012. The RAP utilizes specially modified versions of WRF-ARW for the model component and Gridpoint Statistical Interpolation (GSI) for the analysis component. Work within AMB is currently underway for the second version of the RAP (operational implementation at NCEP likely in 2013). In this presentation, I will describe ongoing work to add two key enhancements for Rapid Refresh short-range guidance applications.

The first enhancement centers on extending capabilities of the GSI cloud analysis, a non-variational procedure in which cloud information from METARS and satellite products are used to adjust hourly cycled explicitly predicted hydrometeors and water vapor. In the original cloud analysis for the RUC, METAR surface data, as well as NESDIS and NASA Langley satellite cloud product data, were used for both building and clearing of cycled cloud hydrometeors (and associated modifications to the co-located water vapor field). Subsequently, it was found that cloud building from satellite data was producing a high bias in mid and upper-level moisture in the analyses and subsequent forecasts (both in the RUC and the RAP). Because of this, no cloud building from satellite data was included in the first version of the RAP. Using more judicious constraints, we have reintroduced cloud building capabilities into the second version of the RAP. Preliminary results indicate that we can successfully build clouds at low levels, without producing a high moisture bias. We will report on these results and describe efforts to extend this capability to higher levels.

The second enhancement focuses on the treatment of rawinsonde data in the analysis. Accurate depiction of the analyzed vertical profiles is important for convective environments and likely plays a key role in shaping the characteristics of convective initiation and evolution in both the RAP and the High Resolution Rapid Refresh (HRRR) model, which is run as a nest within the RAP. Further, realistic representation of details in the rawinsonde observed temperature and moisture vertical profiles is of crucial importance to Storm Prediction Center (SPC) forecasters, who routinely examine model predicted soundings. The GSI formulation used for the first version of the RAP uses specified observation errors and vertical correlation length scales that yield good short-range forecast skill (even down to a 1-h forecast), but provides smooth, undetailed vertical structures in the analysis. We will describe GSI analysis adjustments to improve analysis fit to the rawinsondes, without sacrificing short-range forecast skill.

2E1.4 ID:5417 17:30

A study of precipitation forecast error covariance matrix based on radar reflectivity observations

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The accurate forecast of precipitation represents an unsolved problem in numerical weather prediction. There is a multitude of factors contributing to the errors in precipitation forecasting such as inadequate model microphysics, imperfect initial conditions, insufficient observations, etc. The presence of uncertainty in the forecast is inevitable due to the fact that the ‘true’ state of the atmosphere is never known with absolute certainty. In principle, a good knowledge of these errors can lead to more successful data assimilation and therefore can improve the quality of the forecasts. However, precipitation normally occurs on the meso-scale or convective scale and appropriate observations are required to identify and study the errors at such fine scales. As radar reflectivity measurements furnish high resolution data both in time and space, a good estimate of forecast errors can be obtained by comparing forecast precipitation with radar measurements. Furthermore, by knowing the error covariance matrix of the observations and combining them with forecast data, the error covariance of the forecast model can be obtained. In this study the Canadian GEM numerical forecast model data are compared with the United States composite radar reflectivity observations over parts of North America. First, the model data and radar reflectivity data are remapped and converted to precipitation rates at the ground. Then, an error field is calculated. The errors are defined as the innovation or forecast values minus the observation at each grid point at the surface. Then the characteristics of this error field, such as phase errors and propagation errors, are studied as a function of space and time. Error correlations over time and autocorrelation functions are calculated for different cases. The auto-correlation function of the error is found to have common characteristics as the precipitation field itself. Finally, the statistical characteristics of the error covariance matrix of the forecast are analyzed over multiple cases.

2E1.5 ID:5480 17:45

Evaluation of space based DWL for a hurricane forecast

Michiko Masutani [1], *John Woollen* [2], *Sidney Wood* [3], *Lars Peter Riishojgaard* [4], *Zaizhong Ma* [5], *David Emmitt* [3], *Steven Greco* [3]
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An internationally collaborative effort for Observing System Simulation Experiments called Joint OSSE, has been developed for last several years. Although a large initial investment is required for OSSE, using a OSSE is the most reliable strategy today to assess the quantitative impact from prospective observing systems. The first 13 month long Joint OSSE Nature Run was produced by the European Center for Medium-Range Weather Forecasts (ECMWF) and shared with internationally collaborative Joint OSSE community. Simulation of basic observation for control experiments was completed and shared with Joint

OSSE community.

Lidar technology is the one of the most focused in near future. Particularly space based Doper Wind Lidar (DWL) will provide three dimensional global wind profile is expected to improve NumericalWeather forecast significantly. Due to the cost of DWL, it has been the most important focus of OSSE for last two decades. OSSEs to evaluate the data impact on a hurricane forecast in the Nature Run were conducted in JCSDA. Through this experiments, impact of DWL and model resolution were compared. The results showed significant improvement in both intensity and track for hurricane forecast with DWL in all model resolution.

Nowcasting PART 2 / Prévision immédiate (WAF) PARTIE 2

Room / Endroit (Création), Chair / Président (Ismail Gultepe), Date (30/05/2012), Time / Heure (16:30 - 18:00)

2E2.1 ID:5799 INVITED/INVITÉ 16:30

The future of nowcasting

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A convergence of technical developments has set the stage for a major jump in nowcasting capabilities and the ability to apply those advances to important societal needs. New communications technologies, including broadband Internet, wireless communication, social media, and smartphones, have made the distribution and application of real-time weather information possible nearly anywhere. Rapid increases in the quantity and quality of surface, aircraft, and remote-sensing data now provide a real-time description of atmospheric conditions from the global to regional scales. Improved modeling and data assimilation offer the potential to more effectively apply mesoscale observations and to produce high-resolution analyses and forecasts. Finally, improvements in communication, computation, and control have provided society with the ability to effectively access and use nowcasting information for the protection of life and property, as well as facilitating commerce and recreation. This presentation will describe these individual advances, the synergies of their combination, and how the forecast process might change as a result during the next few decades. It will use examples of real-time nowcasting applications that have been developed for the U.S. Pacific Northwest and will propose an evolution of the responsibilities at local weather forecast offices, with far greater emphasis on nowcastting.

2E2.2 ID:5716 17:00

A climatology of short-range weather forecasts from the High Resolution Rapid Refresh model

Eric James [1], *Curtis Alexander* [1], *Brian Jamison* [2], *Stan Benjamin* [3], *Steve Weygandt* [3]

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The High Resolution Rapid Refresh (HRRR) model is being run hourly in real-time at the Global System Division (GSD) of the Earth System Research Laboratory (ESRL). The model is run out to fifteen forecast hours over a domain covering the entire conterminous United States (CONUS) at a spatial resolution of three kilometers, allowing the use of explicit convection. Initial and boundary conditions are obtained from the 13-km Rapid Refresh (RAP) that will be discussed in a companion presentation by John Brown. In order to learn more about the systematic biases in the HRRR, we have initiated a long-term effort to map the temporal and spatial error patterns for an extensive history of HRRR forecasts. To facilitate this study, we established a real-time archive of two-dimensional HRRR forecast grids starting in late January 2012. In this presentation, we will stratify HRRR forecasts by time of day and lead time in order to discern the model's skill in representing the diurnal cycle of boundary layer structures and moist convection. We will also group forecasts by synoptic weather regimes and by sub-regions of the model domain. Forecasts of low-level winds and cloudiness will be evaluated in the context of the HRRR's utility for use in renewable energy applications. Evaluation of HRRR convective forecasts in regional and diurnal perspectives will be presented and ultimately used to calibrate time-lagged ensemble forecasts of convection. We will provide a description of HRRR time-lagged ensemble convective forecasts and their use as an estimate of thunderstorm likelihood for aviation and severe-weather applications. The talk will conclude with a summary of verification statistics from the multi-month analysis period.

2E2.3 ID:5568 17:15

A comparison of two ensemble-generation nowcasting techniques

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Lagrangian extrapolation of recent radar observations is a widely used nowcasting technique in operational and research centers. However this deterministic technique doesn´t not take into account errors in neither motion determination nor growth and decay.

In this work two different approaches are used to generate ensembles where these uncertainties are introduced. The first approach takes benefit of the well-known predictable large scales (low-pass) and introduces stochastic noise in the small scales (high pass). It has been observed the existence of predictable properties in the small scales that are introduced in the generation of the stochastic noise in order to provide realistic ensembles of different meteorological situations.

On the other hand, the second approach is based on the concept of analogous states. This methodology compares the recent radar observation to a 10 years' radar dataset. The analogues technique looks for similar situations in the past according to rainfall patterns (spatial correlation), storm evolution (temporal correlation) and synoptic situation to generate the ensemble.

The comparison of both techniques towards lagrangian nowcasting and radar observation shows the weak and strong points of each of them as well as provides information for a future merge of both techniques in order to develop a complex analogues-stochastic nowcasting technique.

2E2.4 ID:5395 17:30

High-resolution Numerical Weather Prediction for the October 29 2011 Winter Storm Event over the New York City Area Airports

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A coastal low pressure system moved north along the U.S. East Coast on Saturday, October 29, 2011. A major snowstorm over the New York City area terminals disrupted air traffic, and the timing for rain changing to snow turned out to be a difficult problem that was not well predicted. A mix of snow and rain was forecasted for New York City with heavy snow expected just a few miles north and west of the city. Snow was not forecasted until late evening for the major terminals in the New York City area. NWS forecasters indicated that a mix of rain and snow would begin to fall around 1700 UTC at the Newark airport and gradually develop further east over the JFK and LaGuardia terminals by evening. In fact, a switch to all snow developed rapidly and overspread all three New York area terminals between1500-1600 UTC, although surface temperatures through the event generally remained above freezing. This was a historic event, as New York's Central Park recorded its first snowfall accumulation of an inch or more in October since records began in 1869. A high-resolution dynamical and statistical aviation forecast system based on the Weather Research and Forecasting (WRF) model is being developed at Penn State in cooperation with NOAA/MDL. Short-term dynamical forecasts are created using nested domains with 9-km, 3-km and 1-km grid spacings over the New York City area terminals. The system is configured to run a 3-h pre-forecast data assimilation followed by a 6-12 h forecast every hour, and it will provide 10-minute numerical weather prediction data to a new Local Aviation Model Output Statistics Program (LAMP) for predicting aviation parameters. The WRF cold-start initial conditions and lateral boundary conditions are provided by the 13-km operational RUC (and eventually RR) data. Precipitation-type forecasts adapted from the real-time model are compared to observations for this period, using model fields derived from its Thompson explicit microphysics. The explicit microphysics on the 1-km domain from the 1200 UTC forecast of the baseline version of the system using only standard WMO data produced the changeover to snow by 1600 UTC for the three airports. However, later model forecasts had some difficulty correctly discerning between snow and mixed precipitation for LaGuardia and JFK. Sensitivity experiments including the use of explicit-based versus other precipitation-type algorithms and the assimilation of MADIS surface and ACARS data, and the use of mass-field observations near the surface, are conducted.

2E2.5 ID:5617 17:45

Ensemble retrievals of rain parameters from radar measurements

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Information from remote sensing instruments does not provide direct measurements of quantities of meteorological interest. The latter are obtained by different techniques ranging from empirical relationships to analysis based on data assimilation methods in which the estimation of the error structure of the retrieved quantities is as essential as the values themselves. We will call ensemble retrievals of meteorological quantities from remote sensing measurements the retrievals that sweep the domain of uncertainties and allow obtaining information on the error covariance matrix of the retrieved parameters usable in data assimilation. The idea will be illustrated by the simple classical problem of estimating precipitation water content, M (or precipitation rate, R) from radar measurements. For this, we will use distrometric data, but instead of relating M to reflectivity Z by regression on a scattergram we define M as M=m p(m|Z) or M=m p(m|Z,ZDR) if polarimetric data are available. In this example we use a convective situation observed by the

McGill S-band radar. The conditional probabilities p(m|Z) and p(m|Z,ZDR) are obtained from distrometric data compatible with the observed situation at hand and the selection of distrometric data from convective events (200 days) was made from a 14-years data base. We will show that in this approach it is possible to establish relationships between the diagonal terms of the error covariance matrix and the reflectivity field, estimate the decorrelation distance of the uncertainty in the retrievals and eliminate some possible biases in the retrieved quantities.

Plenary Day 3 / Plénière jour 3

Room / Endroit (Grand salon), Chair / Président (Louis Garand), Date (31/05/2012), Time / Heure (08:30 - 10:00)

P3.1 ID:5442 INVITED/INVITÉ 08:30

Developments in climate reanalysis at ECMWF

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Reanalysis is a method for producing a comprehensive description of the climate as it has evolved in the recent past, based on observations from a mix of conventional and satellite-borne instruments, and constrained by the laws of physics as expressed in numerical models. Reanalyses are used for many different purposes, including studies of climate variability and change. While the quality of successive generations of reanalyses has improved in many respects, accurate representation of low-frequency variability remains a challenge. The fundamental difficulty is that the atmosphere has always been incompletely and inaccurately observed; a reanalysis uses models to complete the picture, but models are not perfect.

This presentation will focus on progress achieved in obtaining 'climate-quality' reanalyses, and prospects for further developments in this area. These include improvements in data assimilation (e.g., the use of variational methods to adjust biases in observations and models); model improvements (e.g., to better represent energy fluxes at the interfaces between atmosphere and surface); and improvements in the observations themselves (e.g., recovery and quality control of historic weather data, and re-processing and inter-calibration of satellite measurements).

Over the years, ECMWF has produced several multi-decadal global reanalyses to support its own research and development in numerical weather prediction, and to serve the needs of scientific users world-wide. ERA-Interim, the latest ECMWF atmospheric reanalysis, covers the period from 1979 onward and continues to be extended forward in time. ERA-Interim provides gridded estimates of a large number of atmospheric parameters at 6-hourly intervals (3-hourly for surface parameters), at approximately 79km global resolution and for 60 atmospheric layers extending from the surface up to 0.1hPa. ERA-Interim data are freely available for research and education, and can be retrieved from ECMWF data servers directly from a browser or by means of python scripts, with options for regional selection and gridding.

P3.2 ID:5292 INVITED/INVITÉ 09:15

Status and Trends in the Global Water and Energy Budget Observations

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Satellite and in-situ observations archived by GEWEX are approaching 30 years with which climate variability and trends can be examined. Immediately evident from the latest versions of the GEWEX products is a lack of closure of the water and energy budgets. The radiation imbalance at the Earth's surface, by the latest estimates is approximately 15 W/ m2, with net radiation into the surface of 115W/ m2 and net losses due to Sensible and Latent Heat losses of only 100W/m2. When time series of these same parameters are examined, however, one can observe very consistent changes in the radiation, evaporation, clouds and precipitation. This suggests that the net imbalance is caused less by measurement errors than by the assumptions and forward models in the algorithms used to derive these parameters. This talk will focus on two such assumptions within the precipitation product as a way of illustrating these issues. The first deals with the potential biases in the precipitation product by improper partitioning of cloud- and rain water in convective clouds. Results from the precipitation algorithm are compared directly to data assimilation results from the ECMWF model when both minimization schemes converge. The second example will deal with discrepancies among long term oceanic precipitation products to ENSO-related warming in the tropical Pacific. The sensitivity of precipitation to a warming ocean can be quite distinct depending upon the observing platform and algorithms employed. This is attributed mostly to the subtle but persistent change in cloud characteristics. The talk will conclude with steps that are being undertaken both by GEWEX as well as the broader community to not only understand the current discrepancies and quantify uncertainties, but also to improve the diagnostics so that comparisons between climate models and observations can go beyond single parameter comparisons to assess the processes that cause errors in the climate models and possibly the observations as well.

New technologies for weather Services PART 1 / Nouvelles technologies pour les services météorologiques (WAF) PARTIE 1

Room / Endroit (Grand salon A), Chair / Président (Edward Szoke), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B4.1 ID:5924 10:30

The Renewal of MSC's Atmospheric Monitoring Program

David Wartman
(Presented by *Martin Elie*)
Director, Atmospheric Monitoring, MSC, Environment Canada
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On January 20, 2012, the Honourable Peter Kent, Minister of the Environment, announced an investment of $78.7 million over the next five years to strengthen atmospheric monitoring infrastructure. The infrastructure upgrades will strengthen the Meteorological Service of Canada's core weather monitoring networks including the weather radar network, which is the backbone of Canada's severe weather warnings service. The areas of weather and climate monitoring infrastructure that will be upgraded include the Canadian Weather Radar Network, the Canadian Surface Weather and Climate Observing Networks, the Canadian Upper Air Network and the Canadian Lightning Detection Network . This new funding complements the

MSC's ten-year strategic plan that addresses critical infrastructure, scientific advancements, life-cycle management strategies and important services delivered to all Canadians. The presentation will provide information on each of the component initiatives as well as give a status report on current plans.

3B4.2 ID:5571 11:00

The Weather Forecasting Process

Robert Ford , *Steve Fougere* , *Steve Miller* , *Kimberly Petrash* , *Chris Sackiw*
Environment Canada
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One of the significant challenges facing operational meteorologists is how optimally to use the new data display technologies in their daily routine. Conventional and supplementary surface, upper air, remotely-sensed and NWP data are now available for superposition and animation. This new capability begs the question of how best to display the data in order to make timely and accurate forecast decisions. This problem is distinct from the one that faced meteorologists in the age of paper charts, though the best principles from those days may be applied and extended to the current situation. In particular, the desirability of retaining an analysis, diagnosis, prognosis cycle is discussed in the context of an ingredients-based approach with data displayed on the NinJo workstation applied to a convective case study over Ontario, Canada. Implications of this approach to operational routines and training are discussed.

3B4.3 ID:5816 11:15

GeoMet: Disseminating weather layers in the Web Map Service (WMS) and KML standards for the general public

Alexandre Leroux
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Meteorological data is increasingly presented and disseminated to the public in map-based, graphical formats. In response to increasing requirements from users, MSC has initiated the GeoMet project and has been developing the required systems in order to disseminate data in the Open Geospatial Consortium (OGC) Web Map Service (WMS) and Keyhole Markup Language (KML) standards.

Displaying Canadian weather data layers on interactive web maps, on smartphones and in Google Earth is only part of what the GeoMet project enables.

A WMS will enable MSC to provide over the Internet georeferenced datasets that are generated by a map server. WMS enables end-users to easily and directly (no file download) access meteorological data using their own tools. Specialized users as well as the general public can then easily access weather data via simple and accessible tools such as on a web page, Google Earth, via a mobile device (eg a smartphone) or through professional tools such as ArcGIS and AutoCAD. Sophisticated users with their own data display systems have the ability to overlay and incorporate meteorological data with their own data. Weather layers disseminated in WMS and KML include temperature, precipitation, cloud cover, pressure and much more.

The GeoMet weather layers were successfully served to external data servers to support the Street Level Forecast prototype during the Vancouver 2010 Olympics in order to test and evaluate some basic functionalities and gather user feedback. Other application examples include the visualization of high resolution urban modeling datasets as well as the development of the "Carte de Vigilance" project within MSC's Quebec Region. The GeoMet project concluded a first public trial in late 2011 and started a second public trial in early 2012.

An update on the progress of GeoMet project will be provided along with plans for the near future.

3B4.4 ID:5572 11:30

An O-QNet VHF wind profiler network study: Upper level divergence, vorticity and the SW Ontario tornadoes of Aug 2011.

Peter Taylor [1], *Zhengqi Wang* [2], *Matthew Corkum* [2], *Shama Sharma* [2]
[1] York University and Zephyr North Canada
[2] York University
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Researchers from York University, University of Western Ontario, and McGill University have now completed the acquisition and installation of a Canadian regional scale network of ten Mardoc WindTtracker VHF wind profilers (the O-QNet) in Ontario and southern Quebec. These are providing a valuable data set of hourly and three-hourly winds from about 400m to 15 km above the surface. We have made a series of comparisons with NWP model analyses and forecasts. We are also using sets of three profilers in triangular arrays to compute upper level divergence and vorticity as indicators of severe summer weather. The approach was originally tested by Zamora et al (1987) but it does not appear to have been used extensively on an operational basis. The goal is to compute divergence and vorticity in real time and supply them to weather forecasters as an additional tool to help identify regions with the potential for severe summer storm development. We are currently looking at data for Aug 21-24, 2011 when several tornadoes occurred in southern Ontario, including an F3 at Goderich. The profiler data show an upper level divergence pattern crossing the region. We are also computing divergence and vorticity patterns from the forecast models in order to compare with the observed patterns. Winter cases will also be investigated to see if probable snowsquall regions can be identified.

Zamora, R.J., M.A. Shapiro, and C.A. Doswell, III, 1987: The Diagnosis of Upper Tropospheric Divergence and Ageostrophic Wind Using profiler Wind Observations, Mon. Wea. Rev., 115, 871-874.

Developments and Applications of High Resolution Prediction Systems PART 1 / Développements et applications de systèmes de prévision à haute résolution PARTIE 1

Room / Endroit (Grand salon B), Chair / Président (Julie Theriault), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B3.1 ID:5652 INVITED/INVITÉ 10:30

The Canadian High Resolution Deterministic Prediction System

Jason Milbrandt [1], *Stephane Belair* [1], *Bertrand Denis* [2], *Manon Faucher* [2], *Anna Glazer* [1], *Francois Lemay* [2]
[1]
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For the past several years, Environment Canada (EC) 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. This system -- now referred to as the High Resolution Deterministic Prediction System (HRDPS) -- is used more and more by operational EC forecasters and the GEM-LAM is used increasingly by researchers throughout the country, both within EC and universities. The transition to formal operation status is now underway and soon the HRDPS will be one of EC's official numerical prediction systems. Over the next few years, we will be working towards replacing the multi-grid system with a single 2.5-km LAM domain covering all of Canada and most of the Arctic.

This talk will provide an overview of the current HRDPS along with a discussion of the research and development that is currently underway towards the development of the national system.

3B3.2 ID:5712 11:00

The High Resolution Rapid Refresh (HRRR): An hourly updating convection permitting forecast system nested in an hourly cycled mesoscale model with multi-scale data assimilation

Curtis Alexander [1], *Steve Weygandt* [2], *Stan Benjamin* [2], *David Dowell* [2], *Tanya Smirnova* [1], *Ming Hu* [1], *John Brown* [2], *Patrick Hofmann* [1], *Eric James* [1], *Haidao Lin* [3]
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The High Resolution Rapid Refresh (HRRR) is a 3-km, convection-permitting model, run hourly in real time at the Global System Division (GSD) of the NOAA Earth System Research Laboratory (ESRL). The HRRR is run out to fifteen hours over a domain covering the entire coterminous United States (CONUS), using initial and lateral boundary fields from the 13-km Rapid Refresh (RAP) mesoscale analysis and prediction system. The RAP system is cycled hourly, using the Gridpoint Statistical Interpolation to assimilate many novel and most conventional observation types including satellite observations. The RAP assimilation system also includes a diabatic digital filter-based radar reflectivity data assimilation procedure to improve specification of the divergent component of horizontal wind in areas of precipitation, a cloud analysis system to initialize stable layer clouds, and special techniques to enhance retention of surface observation information. Recent development of the RAP and HRRR forecast systems has focused on (1) efforts to improve the depiction of the mesoscale environment through refinements to the RAP data assimilation, cloud analysis and model physics and (2) initial testing of 3-km HRRR assimilation of radar reflectivity and radial-velocity data to improve storm-scale prediction particularly in the first few forecast hours. In this presentation, we will document some of the HRRR forecast successes and challenges from both retrospective and parallel real-time evaluations during 2011-2012 where impacts of these recent RAP and HRRR changes are quantified with a multi-scale verification system of reflectivity, precipitation and surface/upper-air forecast fields. Additionally, we will describe the various applications of HRRR forecast guidance for use in severe-weather, aviation and renewable energy communities including use by the National Weather Service (NWS) and Storm Prediction Center (SPC), and collaborative projects such as the Federal Aviation Administration-sponsored CoSPA and the Wind Forecast Improvement Project (WFIP).

3B3.3 ID:5564 11:15

Development of hourly cycling NWP-based Nowcasting Demonstration System at the Met Office for London's 2012 Olympics

Susan Ballard , *Zihong Li* , *David Simonin* , *Jean-François Caron*
(Presented by *Jean-François Caron*)
Met Office
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The Met Office now has an operational NWP system for the UK using a variable resolution version of its Unified Model (UKV) with 1.5km resolution stretching to 4km resolution in the boundary zone. This uses 3 hourly 3D-Var and is nested in the Global 25km NWP system and produces 36-hour forecasts every 6 hours.

We have been testing an hourly cycling NWP based nowcasting system (NDP) at 1.5km resolution with the aim of running in real-time on our new supercomputer in summer 2012. The test system covering Southern England and Wales produces forecasts to at least T+6 and uses the UKV 6hourly NWP forecasts as boundary conditions. A 1.5km or 3km 3D-Var or a 3km 4D-Var analysis system can be used with humidity nudging using an hourly 3D- cloud analysis and latent heat nudging using 15min radar derived surface precipitation. The 3D-Var system uses radar radial Doppler winds once per hour and the 4D-Var system has been tested with Doppler winds up to 6 times per hour. Study of the Fractional Skill Score (Roberts & Lean, 2008) of forecast hourly precipitation accumulations in the 3D-Var system showed an hour's gain in skill in the earliest hours of the forecasts and a positive impact out to T+6 hours due to inclusion of the Doppler winds. Additional benefit has been shown in 4D-Var from the use of more frequent Doppler radial wind data.

The Met Office UK models have all used background errors with fixed, fairly large lengthscale SOAR covariance statistics with variance derived from forecast differences using the NMC method. New background errors have been derived from NDP forecasts with a method that calculates the lengthscales as well as the variances and their impact investigated.

This paper will describe results from the NDP system and comparisons with the current nowcast system.

3B3.4 ID:5332 11:30

Prediction of convective morphology in near-cloud permitting WRF model simulations

Darren Snively , *William Gallus*
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Prior work has shown the most likely type of severe weather varies as a function of convective mode, and thus accurate prediction of mode by numerical models could greatly assist operational forecasters. However, such forecasts are especially difficult because they are not only sensitive to the well-known problem of convective initiation within numerical models, but the mode can change multiple times during a convective system's lifetime. Our current work has performed simulations using the Weather Research and Forecasting (WRF) model at 3-km horizontal resolution, and compared them to observations for 37 warm-season convective events occurring in the central and eastern United States from 2006 to 2010. Ten classifications, adapted from previous studies (Gallus et al. 2008; Gallus and Duda 2010), were the basis for identifying convective mode. The events were objectively scored using a normalized timescale and allowing up to a three-hour initiation/dissipation difference. In addition, the simulated system had to be within 300 km of the observed one to potentially be counted as a correct forecast. We found that the model struggles to produce bow echoes in 13 events, and is also often deficient in developing trailing stratiform regions within

mesoscale convective systems in 12 events. The aforementioned modes were usually delayed during the simulations compared to the observed transitions. Some indication of possible inaccurate depiction of linear forcing around the time of convective initiation or just after was also evident, as five cases simulated a cluster of individual cells instead of a broken line of cells. Environmental parameters, such as convective available potential energy (CAPE) and bulk shear, are being computed to determine if a relationship exists between these measures and the model’s skill at predicting convective evolution. Also, a few events highlighting the major timing and morphology issues are being studied in detail and will be discussed.

3B3.5 ID:5505 11:45

Development and evaluation of a real-time LES-scale numerical weather prediction model

Wanli Wu [1], *Yubao Liu* [1], *Linlin Pan* [1], *Yuewei Liu* [1], *Will Cheng* [1], *Jason Knievel* [1], *John Pace* [2], *Scott Halvorson* [2], *Frank Gallagher* [2]

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Advances in scientific understanding of weather processes, rapid increases in computing power, and demands on precision forecasting of fine-scale severe storms have promoted numerical weather prediction (NWP) development toward to cloud-resolving and large-eddy simulation (LES) scales. Such ultra high resolution NWP possesses great potential for many weather-critical applications such as transport and dispersion prediction of hazardous releases, risk managements and assessments, wind power. Liu et al (2011) has developed a WRF-based multi-scale simultaneous-nestdown data assimilation and forecasting system, which employs a three-dimensional LES turbulence model at 100s meters grid spacing, and uses an improved nudging scheme in fine scale data assimilation. The across scale prediction system has been evaluated in simulating fine scale weather events including tornado-like severe storms and topographic flows in complex terrain regions. It has demonstrated robustness and additional skill at LES scales. The system has recently been adopted for operational wind power forecasting for an offshore wind farm with nested model grid spacing from 24.3km to 300 meters, and implemented at the Dugway Proving Ground (DPG), UT, for experimental forecasting, too. To further develop and evaluate the LES-scale NWP model, week-long simulations with intensive observational data for data assimilation and verification at DPG have been conducted. Some of simulations are run at grid spacing as high as 100 meters to allow direct comparison between explicitly resolved boundary layer turbulence by the 3D LES model and the parameterized one at coarser resolutions, and to understand boundary layer physics for model improvement. In this talk, we will first briefly review this LES scale NWP system and its performance. The focus of the talk is on the assessment of this system on LES model sensitivity and forecasting skill evaluation across scales to explore the added value of the ultra-high-resolution NWP technologies.

Regional Climate Modelling and Climate Projections PART 4 / Modélisation du climat régional et projections du climat PARTIE 4

Room / Endroit (Grand salon C), Chair / Président (John Scinocca), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B6.1 ID:5414 INVITED/INVITÉ 10:30

Added Value Generated by Regional Climate Models

Hans Von Storch , *Frauke Feser*
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An important challenge in current climate modeling is to realistically describe small-scale weather statistics such as topographic precipitation, coastal wind patterns or regional phenomena like polar lows. Global climate models simulate atmospheric processes with increasingly higher resolutions, but still regional climate models have a lot of advantages. They consume less computation time due to their limited simulation area and thereby allow for higher resolution both in time and space as well as for longer integration times. Using regional climate models for dynamical downscaling purposes, their output data can be processed to produce higher resolved atmospheric fields, allowing the representation of small-scale impacts (such as storm surges along coasts). But does the higher resolution lead to an added value when compared to global model results? Most studies implicitly assume that dynamical downscaling leads to output fields superior to the driving global data, but few work has been done to substantiate these expectations. Here, we review the benefit of dynamical downscaling by explicitly comparing results of global and regional climate model data to observations. Regional climate model generally performs better for the medium spatial scales, but not always for the larger spatial scales – specifically when a large-scale constraint such as spectral nudging, is invoked. We conclude that regional models may indeed provide added value, but only for certain variables, scales and locations; in particular when influenced by regional specifics such as coasts, or when sub synoptic-scale dynamics like Polar Lows is involved. Therefore the utility of a regional climate model depends crucially on the scientific question.

The talk is based on the article Feser, F., B. Rockel, H. von Storch, J. Winterfeldt, and M. Zahn, 2011: Regional climate models add value. Bulletin of Amer. Meteo. Soc. 92: 1181–1192

3B6.2 ID:5536 11:00

Dynamical downscaling of CMIP5 GCM simulations over the Africa-CORDEX domain: Evaluating climate variability for the recent past and future climate change

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The World Climate Research Program (WCRP) sponsors the CORDEX project (Coordinated Regional Downscaling Experiment) which aims to produce detailed regional climate data for all land regions of the world in support of climate change impact and adaptation research. The Rossby Centre has performed a suite of dynamical downscaling simulations over the Africa-CORDEX domain, using a new version of the RCA4 model forced by six Coupled GCM simulations from the CMIP5 archive. All simulations cover the period 1950-2100 and are run in transient mode, sampling 3 of the CMIP Reference Concentration Pathways (RCPs). We present an analysis of climate variability over the Africa-CORDEX domain as simulated by RCA4 driven by the six GCMs, focusing on the historical period 1950-2005. Results are compared to an equivalent RCA4 simulation forced by ERA-interim data for the period 1979-2010 and to the respective GCM forcing data. We investigate the degree of coherency between RCA4 and the GCM/ERA-interim boundary data at larger scales, as well as the potential added-value from the higher

resolution of RCA4 at smaller scales. The latter assessment concentrates on simulated precipitation variability, in particular intra-seasonal variability, rainy season onset and decline and intense precipitation events. This analysis forms the basis to which Africa regional climate change projections, derived from the same matrix of simulations can be compared.

3B6.3 ID:5763 11:30

Reanalysis-driven climate simulation over CORDEX North America domain using the Canadian Regional Climate Model, version 5: model performance evaluation

Andrey Martynov [1], *René Laprise* [1], *Laxmi Sushama* [1], *Katja Winger* [1], *Bernard Dugas* [2]

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The Canadian Regional Climate Model, version 5 (CRCM5), has been used for simulating the climate over the North American continent for the 1989-2008 period, using the ERA-Interim reanalysis boundary forcing. The experiment was conducted within the CORDEX project framework aiming at model evaluation and preparation of consequent GCM-driven climate change simulations. The capacity of the CRCM5 model to reproduce the essential phenomena of the North American climate has been estimated, with emphasis on Low-Level Jets and North American Monsoon System. It was shown that the model simulates satisfactorily these climate features, in particular the wind and precipitation patterns, linked with the Great Plains Low-Level Jet (GPLLJ) and the monsoon-driven precipitation patterns over the Gulf of California region.

3B6.4 ID:5376 11:45

CORDEX-Africa climate simulation using the fifth-generation Canadian Regional Climate Model (CRCM5)

Leticia Hernandez-Diaz [1], *René Laprise* [1], *Laxmi Sushama* [2], *Andrey Martynov* [1], *Katja Winger* [1], *Bernard Dugas* [3]

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The new fifth-generation Canadian Regional Climate Model (CRCM5) was driven by ERA-Interim reanalyses for the period 1984 – 2008 over the African continent following the CORDEX experimental protocol. This experiment provided an opportunity to test the model outside its native region, as recommended by the World Climate Research Programme. The diversity of climate regimes over Africa, covering tropical and mid-latitudes in both hemispheres, represents a considerable challenge. Overall the model succeeds in reproducing the main features of the geographical distribution and seasonal cycle of temperature and precipitation, the diurnal cycle of precipitation and the West African Monsoon (WAM). Biases in surface temperature and precipitation in West Africa are related to a circulation bias present in the simulation.

Variability in the northwest Atlantic and northeast

Pacific, and its relation to atmospheric forcing / Variabilité dans l'Atlantique Nord-ouest et le Pacifique Nord-est et relation avec les forçages atmosphériques

Room / Endroit (Symphonie 1), Chair / Président (W.R. Crawford), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B5.1 ID:5606 INVITED/INVITÉ 10:30

Challenges in Projecting Ocean Climate Change in the Northwest Atlantic

John Loder [1], *Augustine Van Der Baaren* [2], *Eugene Colbourne* [3], *Guoqi Han* [3], *Dave Hebert* [1], *Bill Merryfield* [4], *Ingrid Peterson* [1], *Igor Yashayaev* [1]

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The ocean climate off Atlantic Canada is strongly influenced by the North Atlantic’s subpolar and subtropical gyres and its Meridional Overturning Circulation (AMOC), Arctic outflows, freshwater run-off, and pronounced natural variability in these phenomena and in atmospheric forcings such as the North Atlantic Oscillation (NAO). Hydrographic observations from the Labrador Sea show strong multi-decadal variability over the past 70 years associated with these competing influences, resulting in strong modulation of deep convection, such that a clear upper/mid-ocean global warming signature is not yet apparent. Shelf hydrographic, sea level and sea ice observations show multi-year variability associated with the NAO and other atmospheric influences. Many Global Climate Models (GCMs) show an area of relatively weak warming south of Greenland which points to a regional influence of a reduced AMOC predominating over the global warming trend. Fields from selected GCMs such as CanESM2 are examined in relation to the observed climatology and variability to develop insights into potential future ocean climate change in the subpolar gyre and subpolar-subtropical confluence zones off Atlantic Canada, as well as to understand their limitations. Long SST time series such as HadISST are examined to complement subsurface temperature and salinity and other observations from DFO's Atlantic Zone Monitoring Programs in looking for global warming signatures. Potential future changes in both natural and anthropogenic influences are discussed, drawing on work underway in DFO's Aquatic Climate Change Adaptation Services Program.

3B5.2 ID:5749 11:00

Model study of interannual and mesoscale variability in the Labrador Sea

Entcho Demirov [1], *Igor Yashayaev* [2], *Tristan Houser* [1], *Hakase Hayashida* [1]

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The talk will present results from model simulations of the Labrador Sea mesoscale and interannual variability. In this study we use an eddy resolving regional model onf the North Atlantic sub-polar ocean.

The model results are compared with observations. The mechanism of some dominant patterns of ocean variability know from observations are discussed. In particular we study the energy exchange between eddy and mean flow and its impact on the Labrador Sea variability.

3B5.3 ID:5646 11:15

Modeling seasonal to inter annual ocean variability off the coast of British Columbia

Diane Masson , *Isaac Fine*
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The Canadian west coast is located in the transition zone between coastal upwelling in the south and downwelling in the north. Its coastal waters experience strong seasonality and freshwater influence. This work is the first attempt to model ocean conditions along the entire coast of BC, in particular the seasonal cycle and interannual variability of the coastal ocean, including the role of local wind and freshwater forcing. The two objectives of this paper are to validate the newly developed ROMS application for the waters off the coast of British Columbia and to investigate the relative importance of local and remote forcing in establishing the ocean circulation on the BC shelf. The results of the various numerical experiments are discussed in terms of the importance of the various forcing in establishing the annual cycle as well as the interannual variability, including the response of the local ocean to the 1997-1998 El Nino.

3B5.4 ID:5399 11:30

Trends in Oxygen Concentrations in British Columbia Waters.

William Crawford , *Angelica Peña*
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The first thorough examination of oxygen concentrations in Canadian waters of the Pacific Ocean reveals several patterns in space and time and a trend of declining oxygen concentration in shelf waters. Lowest near-bottom concentrations in mid-shelf waters, at typical depths of 125 to 150 metres, are in summer off southwest Vancouver Island in the Juan de Fuca Eddy. A 32-year time series of oxygen concentration at a single station in this eddy reveals declining concentration in late summer over this period, and near-bottom hypoxia in most summers. A numerical simulation of ocean currents and nutrient concentrations in and surrounding the Juan de Fuca eddy in summer reveals persistent upwelling into the centre of this eddy along a canyon, and slow bottom currents within the eddy. We propose that upwelling advects deep, oxygen-poor water onto the continental shelf, and the slow bottom currents allow time for oxidation of organic material in bottom waters to further reduce the oxygen concentration. Upwelled water at bottom of the Juan de Fuca eddy has water properties associated with waters of the California Undercurrent on the 26.6 sigma-t surface. This decline over several decades is attributed to changes in oxygen concentrations on the same density surfaces, rather than to changes in depth of density surfaces, and is related to large-scale wind and climate changes of the North Pacific Ocean.

3B5.5 ID:5439 11:45

Seasonal and Interannual Variability in Marine Conditions on the West Coast of Vancouver Island and in Barkley Sound.

Rich Pawlowicz
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The Barkley Sound Time Series, a monthly time series of water column temperature, salinity, dissolved oxygen and chlorophyll fluorescence measured in the waters of Barkley Sound, British Columbia, is now 8 years long for some parameters. Comparison of observations from two different stations allows for characterization of shelf and inlet waters on the West Coast of Vancouver Island (WCVI), and their changes over time. The time series can also be used to estimate the seasonal variations in the residence times of different parts of Alberni Inlet in Barkley Sound.

Inlet renewal on the WCVI is closely correlated with upwelling-favourable winds on the open coast, and the onset, strength, and length of this period varies from year to year. However, the characteristics of upwelled water (and hence inlet deepwater characteristics in the winter downwelling period after renewal ceases) are not directly related to the strength of the upwelling or its duration.

Chlorophyll biomass also follows a seasonal cycle, but biomass has no apparent relationship to upwelling timing, strength or duration. In addition, no high-biomass spring bloom has been observed, in contrast to observations in the nearby Strait of Georgia. Instead, biomass levels rise sometime in spring to a level that stays roughly constant through the summer. However, the magnitude of the summer biomass is correlated with the timing of the spring increase, with earlier increases being followed by summers with higher biomass. Years in which increases begin in February have almost twice the summer biomass of years in which increases begin in late April. Biomass levels are also correlated with the strength of freshwater inflows in summer, with higher biomass associated with lower flows.

Nowcasting PART 3 / Prévision immédiate (WAF) PARTIE 3

Room / Endroit (Symphonie 2), Chair / Président (Claude Landry), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B2.1 ID:5460 10:30

Testing the utility of meteorological objects in warning scenarios - an iCAST update

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A prototype nowcasting system known as iCAST (interactive Convective Analysis and Storm Tracking) has been developed at Environment Canada to test forecast approaches that combine the skills of human forecasters with the strengths of computer techniques. The system allows for human-computer interaction in analysis, diagnosis and prognosis using meteorological objects (met objects) in a graphical database. Met objects are defined as time- and geo-referenced representations of atmospheric features and fields, such as points, lines, areas, or tracks. They can be derived from surface observations, satellite imagery, radar data, NWP guidance, output from computer processes, or other met objects. The derivations are meant to enhance the understanding and utility of the original data, making use of both the geographical representation as well as applying attributes that describe characteristics or actions of the objects.

The iCAST system has used this approach for a number of years in a real-time operational setting on the

Research Support Desk at the Ontario Storm Prediction Centre in Toronto, in support of the summer severe weather program. Examples from the 2011 season will be shown, including verification of thunderstorm nowcasts using lightning data.

Sequences of met objects can be used to describe the evolution of meteorological parameters, an event-based approach to forecasting. This approach is being investigated in support of MSC's 'Re-engineering the Weather Warning and Service Delivery System' Signature Project to test whether the essential information of weather warnings and advisories can be captured with met objects, so as to enhance the production of graphical and textual warning information.

3B2.2 ID:5343 10:45

Assessment of the High-Resolution Rapid Refresh model in predicting large-scale convective systems

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The High-Resolution Rapid Refresh (HRRR) model, as the name implies, is a high-resolution (3 km) model that cycles every hour, assimilating a host of data including radar reflectivity, to provide forecasts over the United States and surrounding areas. This model is particularly useful for short-term forecasting of rapidly evolving weather systems and it continues to be upgraded in order to improve the simulation of convection with significant code changes being implemented between 2010 and 2011. In this study, we assesses the HRRR's performance in predicting convective initiation (CI) of storms larger than 100 km with a particular focus on the initiation of mesoscale convective systems during June, July and August of 2010 and 2011. Bulk statistical comparisons indicate that the HRRR produced similar numbers of large-scale CI events compared with observations during both summers, while also closely replicating the diurnal cycle of large-scale CI. However, regional differences between the model-forecasted CI and observed CI were evident. For example, the model tended to underpredict large-scale CI associated with the sea breeze front along the Gulf Coast as well as large-scale CI in the vicinity of the dry line in eastern New Mexico and west Texas. More detailed analysis reveals the model's skill in predicting specific large-scale CI events. Differences in the performance of the HRRR between 2010 and 2011 will be discussed.

3B2.3 ID:5463 11:00

Integrated Nowcasting System: First Operational Version

Claude Landry [1], *Jean-François Deschenes* [2], *Matthew Holly* [2], *Laura Huang* [3], *George Isaac* [3], *Donald Talbot* [2], *Jean-Pierre Talbot* [2]
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The first operational version of the Integrated Nowcasting System (INCS) was implemented at CMC last October 2012. After being an experimental prototype for a few years this version 1.0 includes many changes. The INCS produces at every hour a set of nowcasting matrices for about 500 sites over Canada. These matrices are used to feed the operational Scribe forecast production tool with the latest observations and very short range forecast. Changes to the data used as input to the system have increased the performance of most forecasted weather elements. The INCS Scribe interface tool box was redesigned to provide more reliability and flexibility to the forecaster and more configuration options. This new interface will be soon available on the forecaster's desk through Reference Implementation RI 10.0. Verification

results and forecast examples will be presented as well as a description of the new interactive approach of the Scribe Interface. Future developments and collaboration projects with Cloud Physics and Severe Weather Research Section will also be presented.

3B2.4 ID:5346 11:15

Challenges and Developments in Very-short-range Forecast of Significant Convection for Aviation Applications in Hong Kong

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In supporting forecasts of significant convection and the associated high-impact weather phenomena over Hong Kong Flight Information Region (HKFIR) and Hong Kong International Airport (HKIA), nowcasting techniques are used to provide robust and rapidly-updated guidance on identification and movement of thunderstorms. In this presentation, a severe convection event occurred in the late morning of 18 September 2011, which caused significant impact on air traffic flow over HKFIR, will be discussed to illustrate the performance of radar-based nowcast products. Benefits of using radar-derived product like vertically integrated ice, and different echo tracking techniques in thunderstorm nowcast will be discussed. This will be followed by discussion on the role play by inputs from convection-resolving numerical weather prediction (NWP) model to capture the intensity change of significant convection beyond 3 hours. Results from the operational Non-Hydrostatic Model (NHM) system of Hong Kong Observatory called RAPIDS-NHM, running with horizontal resolution at 2 km, will then be presented. Challenges in blending of model forecast with nowcasting products for significant convection prediction will be highlighted. Further improvements in model capability to capture the development of convection via data assimilation of radar data will also be given in the presentation.

3B2.5 ID:5320 11:30

A computer algorithm to nowcast snowfall amounts from lake-effect snow using both satellite and model data

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Lake-effect snow is a common winter phenomenon over the Great Lakes when cold Arctic air flows over the warm water surface, setting up an unstable boundary layer in which convective clouds develop and are carried downstream. These convective clouds, albeit shallow, can spread narrow bands of heavy snow to downwind communities. These heavy snow bands pose a significant weather hazard to such communities, causing airport shutdowns and dangerous driving conditions. The synoptic pattern favourable for lake-effect snow is usually well forecast by NWP models. However, they cannot forecast the exact locations and snowfall amounts of the snow bands. Mesoscale modelling offers some help but can still suffer from large uncertainties in both the location and amount since the snow bands can be as narrow as a few kilometres. In this study, we are proposing a nowcasting algorithm to estimate snowfall amounts from lake-effect snow using both GOES satellite and GEM Regional model data. Lake-effect snow bands identified from a satellite image are actually snapshots of the time evolution of the cumuli growth from the initial to the mature stage. As a result the cloud-top cooling rates along the bands during the growth stage can be derived. These cloud-top cooling rates reflect the underlying dynamic and thermodynamic forcings. Using the cloud-top cooling rates and model sounding data, parcel vertical velocities and hence the moisture flux can be estimated. Consequently, the snowfall amounts at different points along each band can be estimated. Applying this nowcasting algorithm to several lake-effect snow events downwind of Lake Huron in Dec 2010 and in Jan 2012 shows some promising results. More advanced work is planned to further improve the

applicability and accuracy of the algorithm.

3B2.6 ID:5427 11:45

Thermodynamic and Wind Profiling at International Airports

Randolph Ware [1], *George Isaac* [2], *Robert Crawford* [2], *Ismail Gultepe* [2], *David Hudak* [2], *Paul Joe* [2], *Alister Ling* [2], *Brent Shaw* [3], *John Zack* [4], *Marta Nelson* [1], *Rob Reed* [2]

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Environment Canada operates a Radiometrics microwave radiometer profiler at the Pearson International Airport as part of the Canadian Airport Nowcasting Project (CAN-Now). All-weather temperature and humidity with radiosonde- equivalent assimilation accuracy, and cloud liquid water profiles are automatically retrieved from the radiometer observations. Mature software (www.raob.com) combines thermodynamic and wind (forecast or observed) profiles and generates a full suite of real time traditional Forecast Tools and Indices in familiar format. Local high impact weather prediction can be improved using continuously updated Forecast Tools and Indices or via assimilation of continuous upper air profiles into numerical weather models. We present example continuous upper air profiles and derived Forecast Tools and Indices from Toronto, Yellowknife, Los Angeles and Dubai International Airports.

AMS-NWP-WAF: Overview of operational systems PART 3 / Survol des systèmes opérationels PARTIE 3

Room / Endroit (Symphonie 3A), Chair / Président (Gilbert Brunet), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B1.1 ID:5487 10:30

The third upgrade of NOAA's National Centers for Environmental Prediction's Real-Time Mesoscale Analysis

Manuel S.f.v. De Pondeca [1], *Geoffrey S. Manikin* [2], *Yanqiu Zhu* [1], *Steven Levine* [3], *Geoff Dimego* [2], *R. James Purser* [1], *David F. Parrish* [2], *Dennis Keyser* [2], *Jamie Vavra* [4]

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This work reports on the third upgrade of NOAA's National Centers for Environmental Prediction's Real-

Time Mesoscale Analysis (RTMA) that is scheduled for 2012. The RTMA is a high spatial and temporal resolution 2DVar-based analysis system which currently provides hourly analyses of surface pressure, 2-m temperature, specific humidity, and dew point, 10-wind, accumulated precipitation, and sky cover on selected National Digital Forecast Database (NDFD) grids. It was first implemented in 2006 for the 5-km resolution conterminous US (CONUS) grid. An upgrade followed in 2008, with the system's implementation for the 6-km Alaska, and 2.5-km Puerto Rico, and Hawaii grids. The implementation in 2010 for the 2.5-km Guam grid, the resolution increase to 2.5-km for RTMA-CONUS, and the addition of several 2DVar enhancements constituted the second upgrade.

Highlights of the upcoming third upgrade include: (i) the replacement of the Rapid Update Cycle by the Rapid Refresh Cycle as the model providing part of the 2DVar first guess; (ii) the use of multi-model blended forecasts as the first guess, including the blending in of the wind field from the Hurricane Weather Research and Forecast system to improve the analysis of tropical systems; (iii) the horizontal resolution doubling to 3-km for RTMA-Alaska; (iv) the RTMA implementation for Juneau, Alaska, at 1.5-km resolution, and for the Northwest River Forecast Center area at 2.5-km resolution; (v) the analysis of visibility and 10-m wind gust; (vi) the use of diurnal blacklists for temperature and moisture observations, and direction-stratified blacklists for wind observations; and (vii) the use of cross-validation to improve the estimate of the magnitude of the analysis uncertainty for each analyzed parameter. Results from the upgrade package will be presented and discussed at the meeting.

3B1.2 ID:5721 10:45

Rapid Refresh Replaces the Rapid Update Cycle at NCEP

John Brown [1], *Stephen Weygandt* [1], *Tanya Smirnova* [2], *Ming Hu* [2], *Curtis Alexander* [2], *Stan Benjamin* [1], *Haidao Lin* [3], *Joseph Olson* [2], *Patrick Hofmann* [2], *Brian Jamison* [3], *David Dowell* [1]

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The Rapid Refresh (RAP) mesoscale analysis and prediction system is scheduled for operational implementation at the National Centers for Environmental Prediction (NCEP) of the USA National Weather Service in March 2012. The RAP replaces the Rapid Update Cycle (RUC) system at NCEP, incorporating design enhancements including: 1) an expanded domain covering all of North America including Alaska and the Caribbean on a rotated cylindrical equidistant horizontal map projection, 2) coordinated use of specifically adapted versions of the gridpoint statistical interpolation (GSI) analysis system and the advanced research WRF (ARW) prediction model, 3) inclusion of a satellite radiance assimilation package within the GSI.

Unique data assimilation features from the RUC and other aspects of the analysis will be discussed in a companion presentation by Ming Hu. For the WRF-ARW model, where possible we have chosen to use physics schemes that are advanced versions of those used in the RUC. It was also necessary to introduce a digital filter initialization capability into the WRF-ARW including a diabatic component for radar reflectivity assimilation. This initialization capability and several physics upgrades are included in the WRF community repository at the National Center for Atmospheric Research (NCAR). In this paper, we will provide a description and evaluation of the NCEP implementation version of the RAP using a multi-scale verification system with emphasis on the configuration of the WRF-ARW model and the model physical parameterizations, as well as case-study examples. We will also discuss ongoing / planned work toward a 2nd generation version of the Rapid Refresh, RAP2 (operational implementation expected at NCEP in 2013).

This research is partially in response to requirements and funding by the Federal Aviation Administration (FAA) of the USA. The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

3B1.3 ID:5609 11:00

HPC enabling NWP at the Canadian Meteorological Centre

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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 overview of the current and future NWP modeling systems running at CMC as well as the High Performance Computing systems in support to them. In particular, we'll report on our recent IBM supercomputer migration.

Atmosphere, Ocean and Climate Dynamics PART 3 / Dynamique de l'atmosphère, des océans et du climat PARTIE 3

Room / Endroit (Symphonie 3B), Chair / Président (Michael Waite), Date (31/05/2012), Time / Heure (10:30 - 12:00)

3B8.1 ID:5585 10:30

The Temporal Autocorrelation Structure Of Sea Surface Winds

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The temporal autocorrelation structures of sea surface vector winds and wind speeds are considered. Analyses of scatterometer and reanalysis wind data demonstrate that the autocorrelation functions (acf) of surface zonal wind, meridional wind, and wind speed generally drop off more rapidly in the middle latitudes

than in the low latitudes. Furthermore, the meridional wind component and wind speed generally decorrelate more rapidly than the zonal wind component. The anisotropy in vector wind decorrelation scales is demonstrated to be most pronounced in the storm tracks and near the equator, and to be a feature of winds throughout depth of the troposphere. The extratropical anisotropy is interpreted in terms of an idealised kinematic eddy model as resulting from differences in the structure of wind anomalies in the directions along and across eddy paths. The equatorial anisotropy is interpreted in terms of the kinematics of large-scale equatorial waves and small-scale convection. Modelling the vector wind fluctuations as Gaussian, an explicit expression for the wind speed acf is obtained. This model predicts that the wind speed acf should decay more rapidly than that of at least one component of the vector winds. Furthermore, the model predicts a strong dependence of the wind speed acf on the ratios of the means of vector wind components to their standard deviations. These model results are shown to be broadly consistent with the relationship between the acfs of vector wind components and wind speed, despite the presence of non-Gaussian structure in the observed surface vector winds.

3B8.2 ID:5624 10:45

Dynamics and transport of a quasigeostrophic circumpolar current

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A simple theory for the transport of the a wind-driven Antarctic Circumpolar Current is developed and predicts a saturation regime, in which transport is roughly independent the forcing amplitude. The theory relates the transport to a portion of the Sverdrup flux into Drake Passage latitudes and assumes the remaining portion of this flux to feed a recirculation gyre. This is compared with numerical simulations in large domains, carried out for a wide range of parameters. The simulations verify the basic idea that the circumpolar flow (in the saturation regime) extends from a Sverdrup circulation; however, the partitioning of the Sverdrup flux into circumpolar and recirculating flow turns out to be more subtle than assumed by the theory. For example, saturation circumpolar transport in a reference simulation is weaker than that predicted by the theory; moreover, the addition of a topographic continental ridge along the western boundary increases the strength the recirculation, thus further reducing the circumpolar transport. A similar effect is observed for decreasing bottom drag. We also note an intriguing difference between simulations for which the model Drake Passage is blocked by an idealized (e.g., Gaussian) ridge and simulations which assume more realistic topography. In the idealized-ridge simulations, a tight topographically-trapped recirculation, whose amplitude depends on forcing and dissipation parameters, appears --- and seems to affect the circumpolar transport. With realistic topography, the form drag needed to balance the zonal momentum budget is not constrained to be localized to the Drake Passage region. Because of this, strong topographically-trapped recirculations do not appear, and the model transport conforms better (at least in a qualitative sense) with the simple theory. To summarize, the theory assumes the transport to be linked to a Sverdrup-like flow north of Drake Passage lattitudes; simulations with idealized topography clearly show a Sverdrup circulation; however, can disagree with the theory, in part due to a topographically-trapped (and arguably unrealistic) circulation which develops. In simulations with more realistic topography, the Sverdrup flow is not evident; however, a saturation of transport occurs in a manner similar to that predicted.

3B8.3 ID:5584 11:00

Energy Fluxes in the baroclinic double gyre problem

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We consider the baroclinic double gyre problem over a range of forcing and dissipation parameters. The classic view has that energy input mainly to the baroclinic mode at large scales readily cascades forward in wavenumber space to a Rossby radius-like scale. There, baroclinic energy `barotropizes', and is thought to fuel an inverse cascade of barotropic energy, essentially between the Rossby radius and Rhines scales. We find instead that barotropization extracts baroclinic energy from scales near the Rossby radius, but that this energy is injected directly into scales related to the Rhines scale. As such, there is not (net) inverse cascade of barotropic energy. Instead, we find a however, a robust "double cascade" of barotropic energy in which a non-linear inverse cascade is compensated for by a forward cascade associated with the beta term. The fluxes and transfers relating to various terms are discussed for both the barotropic and baroclinic modes, as is the appearance of zonal jets, which are also clearly evident in instantaneous fields over a large parameter range.

3B8.4 ID:5281 11:15

Meridional flow of grounded abyssal ocean currents on a sloping bottom in spherical geometry

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Many of the abyssal currents in the oceans, associated with the equatorward motion of deep water masses produced by atmospheric cooling in high latitudes, are organized as mesoscale topographically-steered geostrophically-balanced grounded gravity currents that flow along sloping continental boundaries. These currents form an important component in the deep “leg” of the meridional overturning circulation in the oceans. The spatial extent of these abyssal currents is hemispheric in scale. This raises the question of the role of planetary sphericity and differential rotation (from the viewpoint of the underlying local geostrophic balance) in determining the large scale kinematic structure of these flows. A steady nonlinear planetary-geostrophic model in spherical coordinates is presented describing the hemispheric-scale meridional flow of grounded abyssal currents on a sloping bottom. The model, which corresponds mathematically to a quasi-linear hyperbolic partial differential equation, can be solved explicitly for a cross-slope isopycnal field that is grounded (i.e., intersects the bottom on the up slope and down slope sides). The solutions possess decreasing abyssal current height in the equatorward direction while maintaining constant meridional mass flux and exhibit westward intensification as they flow toward the equator.

Climate Data Homogenization and Trend Analysis PART 2 / Homogénéisation des données climatologiques et analyse de tendances PARTIE 2

Room / Endroit (Symphonie 4), Chair / Président (Lucie Vincent), Date (31/05/2012), Time /

Heure (10:30 - 12:00)

3B7.1 ID:5293 10:30

Canadian climate data from archival sources: a community-based data rescue project.

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In 2010, a community-based volunteer project was launched to digitize climate data found in Canadian archives. The project concentrates on meteorological and climatological data found in archives and other historical sources for the period before the foundation of the Meteorological Service of Canada in 1873. The earliest systematic daily instrumental weather recordings in Canada started in 1743; there are nearly continuous daily instrumental recordings in the St-Lawrence Valley since 1798. More sporadic data from Atlantic Canada, starting in 1786, are being digitized, and previously digitized records from the Hudson Bay region, starting in 1730, are also in the process of being edited. Twenty volunteers have to date entered over 200,000 individual observations of temperature, pressure, precipitation, and weather from over 20 journals. The differences in observing practices, instruments and locations make the task of evaluating the quality and homogeneity of these data a challenge. Statistical methods are used to assess the quality of the early historical data, and to compare historical and modern data. One of the difficulties in comparing historical temperature readings to 20th century temperature series is the difference in observing practice: the historical observations tend to be at fixed hours, while the 20th century, especially early 20th century, homogenized data are maximum and minimum temperatures. Regression analysis is used to estimate minimum and maximum temperatures from fixed-hour readings. Methods of comparing historical and modern weather observations are also considered.

3B7.2 ID:5762 10:45

Correcting Inhomogeneities in Daily Time Series - Comparison of Methods for Various Meteorological Elements

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The homogenization of climate data is of major importance because non-climatic factors make data unrepresentative of the actual climate variation and the conclusions of climatic studies are potentially biased. Instrumental series of various meteorological elements are often affected by inhomogeneities. Several methods are available for their correction, either on monthly or, in the last decade, also on daily data. In this work we focused especially on comparison of methods for daily data inhomogeneities correction. Two basic approaches for the adjustment of inhomogeneity were adopted and compared: (i) the “delta” method – the adjustment of monthly series and projection of estimated smoothed monthly adjustments into an annual variation of daily adjustments (e.g. Vincent et al. 2002) and (ii) the “variable” correction of daily values according to the corresponding percentiles, e.g. HOM (Della-Marta and Wanner, 2006), SPLIDHOM (Mestre et al., 2011), DAP (Stepanek 2009) and Quantile Matching (Wang 2009 and 2010). The “variable” correction methods have only emerged in the recent years. They were applied in this work to the COST ESO601 daily validation dataset (air temperature) and also to the various meteorological elements based on the data from the Czech Republic. Their results were mutually compared and investigated. The results were processed via the software ProClimDB (Štěpánek, 2010, www.climahom.eu) and R (www.r-project.org).

3B7.3 ID:5836 11:00

Climatic trends and variations as observed at Nanyue Mountain Observatory in recent 58 years

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Nanyue Mountain Observatory is a unique high-elevation meteorological station in Hunan Province of China, located at 27.30°N, 112.70°E, and 1268 meters above mean sea level. In this study, the climatic trends and variations observed at this station in the 1953–2010 period are examined using linear regression, Mann-Kendall test, and wavelet analysis. Our results show that both annual and seasonal mean wind speeds had significant decreasing trends during this 58-year period, with some abrupt changes identified in the early 1990s. The decreasing trend of wind speed in summer is largest, followed by the trends in spring, autumn, and winter. The temporal variations in wind speed are characterized by three quasi-oscillation periods of 2-3 years, 5-8 years, and 16 years. The daily mean, maximum and minimum temperatures experienced significant increasing trends, except for the daily maximum temperature in the summer season. Abrupt changes toward warmer conditions occurred in the mid-1990s. Three quasi-oscillation periods of 2-4 years, 7-9 years, and 16 years are identified in the temperature variations. There is a weak decreasing trend in the annual precipitation records. More specifically, the precipitation in summer is increasing while those in other seasons are decreasing. The three noticeable quasi-oscillation periods in precipitation are 2 years, 4-6 years, and 21 years, respectively.

Our analysis shows that the wind speed is negatively correlated with daily mean, maximum, and minimum temperatures at Nanyue Mountain Observatory. The corresponding correlation coefficients are -0.48, -0.37, and -0.53, respectively, and all of them are statistically significant at the 99% confidence level. The correlation coefficient between wind speed and precipitation is less significant. However, an anti-phase relation between them can be found in the mid-1960s, mid-1970s, and the first few years of the current century.

3B7.4 ID:5845 11:15

Methods for calculating surface temperature anomalies and trends in the province of British Columbia 1901-2011.

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Estimates of regional mean annual surface temperature anomalies are instrumental for giving a picture of climate variability and change. Increasingly, such estimates are desired soon after year end or on a near real-time monthly basis. We present an approach for calculating these anomalies on smaller scales and over regions defined by political boundaries using unhomogenized data. We utilize Thiessen polygons and area weighted means to calculate the anomaly in mean annual temperature for British Columbia. We calculate a 2011 temperature departure for the province of 0.07 ± 0.17 degrees C relative to the 1971 - 2000 normal. Uncertainty in the estimate is derived from creating multiple realizations of observation networks of various sizes and examining the statistical distribution of resulting temperature calculations. We find that uncertainty is proportional to 1/(N^0.5). Relying on evidence that homogeneity issues are less important for aggregate data and when analyzing mean daily temperatures we calculate trends in provincial mean temperature departure from the 1971-2000 climate normal. For the period 1956-2005, results show that the mean annual temperature of British Columbia has increased by 0.29 ± 0.14 degrees C per decade

which is substantially larger than the global mean rate of temperature rise reported in the IPCC report of 0.13 ± 0.03 degrees C per decade. These results are compared with an identical analysis using the more reliable but spatially sparser Adjusted Historical Canadian Climate Dataset to demonstrate any costs in reliability arising from producing regional estimates in near real-time using uncorrected data.

3B7.5 ID:5350 11:30

Benchmarking and Assessment of Homogenisation Algorithms for the International Surface Temperature Initiative

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The International Surface Temperature Initiative (ISTI), endorsed by the WMO Commission for Climatology, was launched at a meeting at the UK Met Office, Exeter in September 2010. To meet the requirements placed on climate science in the 21st Century, it is necessary to create high quality and high resolution climate data products, with openness and transparency along with verification and user tools. This initiative is envisaged to be international and interdisciplinary, involving climate scientists, statisticians, metrologists and software engineers from around the world. The initiative covers: data rescue and digitisation; an open, transparent and comprehensive databank with versioning and provenance tracking; a data-portal for multiple climate products; a common benchmarking and assessment process; and platforms for data download, intercomparison and visualization. The objective of the Benchmarking and Assessment working group is to facilitate the use of a robust and independent common benchmarking and assessment system for temperature data products creation methodologies (especially for homogenisation), to aid product intercomparison, uncertainty quantification and methodology advancement. A poster will summarize the main tasks of the working group.

DA V: Predictability / Prédictabilité

Room / Endroit (Grand salon A), Chair / Président (Brian Colle), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C1.1 ID:5476 14:00

Targeted observations for improving numerical weather prediction: an overview

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“Targeted observations” refers to the selection of additional, specially chosen observations to be assimilated into operational numerical weather prediction models. Observation locations are chosen in order to improve forecasts of high-impact weather events of importance to society. Examples include dropwindsondes launched from aircraft or balloons, additional rawinsonde ascents, remotely sensed observations, and the inclusion of enhanced regular satellite observations (such as radiances or winds) that may normally be excluded from data assimilation due to routine thinning or quality control procedures. As a consequence of many field campaigns worldwide during the past decade, advancements have been made in the development of objective strategies for targeting observations, and in quantitative evaluations of the impact

of assimilating these extra observations on numerical weather predictions. The successes and shortcomings of these efforts are summarized here. Based primarily on a review by the WMO / THORPEX Data Assimilation and Observing Systems Working Group, recommendations are made to the community for the use of targeted observations in the future to maximize the impact on forecasts.

3C1.2 ID:5498 14:15

Tropical cyclone data impact studies: Influence of model bias and synthetic observations

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The impacts of dropsondes and enhanced atmospheric motion vectors on tropical cyclone track forecasts are examined in a series of experiments using the Navy global operational data assimilation and forecasting systems. Two tropical cyclones, Nuri and Jangmi, are examined in detail, with a focus on how model error may influence or lessen data impact. For Nuri, it is found that dropsondes and enhanced atmospheric motions vectors are at least as likely to degrade as to improve forecasts. Examination of the synoptic forecast fields indicates that a persistent forecast bias resulting in a weakening of the subtropical anticyclone over the western North Pacific results in erroneous recurvature that is not corrected with additional data. For Jangmi, additional data, particularly enhanced satellite winds, is found to improve the track forecasts in most cases. Examination of model biases indicate that a persistent weakening of the subtropical high is also contributing to the track errors for Jangmi, but there is evidence that assimilation of the enhanced satellite winds mitigates this error to some extent. Experiments in which the error assigned to synthetic tropical cyclone observations is increased lead to improvements in track forecasts on average for both Jangmi and Nuri, suggesting that a reformulation of the synthetic tropical cyclone observation scheme may lead to improved forecasts as more in-situ and remote observations become available.

3C1.3 ID:5387 14:30

Using short-term physical tendencies to study the dynamical balance of atmospheric models

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Rodwell and Palmer (2007) have proposed to use diagnostics based on short-term physical tendencies of the model when analyses are used as initial conditions. Such diagnostics provide useful information about the consistency of the physics as it relaxes to the model's own climatology in the first moments of the integration. For global climate models, a long integration is done to spin-up the model to its own climatology and this imbalance is of little consequence except for model validation comparing a climate run against reanalyses. The problem however is more serious for regional climate models which are driven by either reanalyses or a global climate run often obtained from a different model. In a set of experiments, short integrations were performed with the Canadian Regional Climate Model (CRCM), a limited-area configuration of the global model used by the 3D and 4D-Var assimilation. Short integrations were done with initial conditions based on the 4D-Var analyses, and the diagnostics revealed imbalances slightly more important than in a similar experiment with the global model. Using ERA-interim reanalyses led also to a significant imbalance comparable to those of the experiment with the global model. Other experiments were also conducted in which the model boundary conditions driving the model are provided every 6-h. Using 4D-Var analyses and ERA-interim reanalyses to define the boundary conditions, the results showed more

important imbalances for the ERA-interim integrations as was observed in other experiments with the global model. We conclude from these results that the diagnostics used by Rodwell and Palmer (2007) are very useful to detail the nature of the imbalances in climate models. Our results show that differences between the model driving a regional climate model and the RCM can create imbalances that could artificially alter the model's internal variability.

3C1.4 ID:5491 14:45

Multi-scale predictability aspects of a severe European winter storm

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A severe winter storm, referred to in the media as Xynthia, crossed Western Europe on 26–28 February 2010 and has been described as the most intense in this region in more than a decade. The violent storm claimed the lives of more than 50 people with many of the deaths in France related to strong winds and a storm surge that caused a rapid rise in water. Hurricane force winds were reported along the Atlantic Coast of France flooding low-lying coastal areas. The storm produced heavy rains, and strong winds, which caused widespread power failures and severely impacted the transportation system including numerous airport closures and delays in rail traffic. The insured losses from the storm are projected to be $2 to $4.1 billion (AIR Worldwide).

In this study, the recently developed adjoint and tangent linear models for the atmospheric portion of the nonhydrostatic Coupled Atmosphere/Ocean Mesoscale Prediction System (COAMPS) are used to explore the mesoscale sensitivity and predictability characteristics associated with the severe extratropical cyclone. Unique aspects of the adjoint modeling system include a full adjoint to the microphysics and a nested grid capability that allows for multi-scale sensitivity calculations. The adjoint is applied using the nesting option with 45 and 15 km meshes for a series of forecasts initialized during the 27-28 February time period. Results indicate that 12 h and 24 h forecasts of intensification of the extratropical cyclone in Western Europe are very sensitive to the initial state. The adjoint-based sensitivity fields indicate highly structured patterns in the wind, thermal, and microphysical fields that project on to the model simulated deep convection, which ultimately influences the intensification rate. Relatively small basic state perturbations based on the adjoint calculations on the order of observational errors (1 m/s, 1 K) lead to rapid growth rates in the near-surface horizontal velocity and deepening rate of the central pressure. The sensitivity of the adjoint results to the horizontal resolution and microphysical parameterization will be discussed. Implications of the adjoint-based sensitivity fields for the predictability of mesoscale aspects of Xynthia will be addressed.

3C1.5 ID:5607 15:00

Convective-scale predictability experiments during the COPS field campaign

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Operational weather centres are increasingly using “convective-scale” forecasts that permit deep convection to explicitly develop on the model grid. Although this is necessary for detailed regional storm prediction (and to eliminate the need for error-prone cumulus parameterization schemes), the forecast skill is often mitigated by rapid error growth at smaller scales. This motivates the use of convective-scale ensembles, which consider different sources of uncertainty to yield a spread of plausible convective responses. Along

with their practical forecasting benefits, these ensembles may provide valuable insight into the multi-scale sensitivities of convective storms. The current study uses convective-scale ensembles with the Met Office Unified Model to analyze two convection events during the COPS (Convective and Orographically induced Precipitation Study) field experiment over central Europe in 2007. The complex terrain of this region forces well constrained mesoscale circulations that in principle may increase the predictability of storm initiation. The two cases occurred in two very different large-scale settings; the first involved an isolated mountain thunderstorm under weak large-scale subsidence and the second involved a pre-frontal squall line within a strong mid-latitude cyclone. The ensembles are verified against intensive COPS observations and interpreted to identify the mechanisms by which initial errors on the large scale control the convective-scale response. In both cases, subtle uncertainties in the strength and position of upstream potential-vorticity (PV) anomalies over the Atlantic Ocean led to large ensemble spread on the convective scale.

3C1.6 ID:5406 15:15

Simulation of the July 2011 Korean Flood with the NCAR RTFDDA Modeling System

William Cheng [1], *Yubao Liu* [1], *Yuewei Liu* [1], *Linlin Pan* [1], *Gregory Roux* [1], *Young-Jean Choi* [2], *Seung-Woo Lee* [2], *Beom-Keun Seo* [2], *Young-San Park* [2], *Song-Lak Kang* [3]

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A heavy rainfall event occurred during 25 - 27 July 2011 in the Korean Peninsula, which caused flash floods in the South Korean provinces of Seoul and Gyeonggi and left 70 people dead. As much as 99.5 mm of rain fell in just one hour in the capital, Seoul, the third highest hourly rate recorded in the country since rainfall data collection began in 1907. In addition, this heavy rainfall event caused power outages and left more than 34,500 houses submerged and caused transport problems with roads being cut off and bridges having to be closed. Favorable large-scale synoptic conditions for this event included: i) vorticity maximum moving over the Korean Peninsula; ii) low-level frontal boundary; iii) warm and moist southerly flow. The operational models at the Korean Meteorological Center (KMA) did not predict this event very well. In this paper, the NCAR WRF-based real-time four-dimensional data assimilation (RTFDDA) and forecasting system was employed to study the physical and dynamical processes and the predictability of this heavy rain event. Initial experiments with RTFDDA using conventional observations (dx = 3.3 km) showed that the WRF-RTFDDA captured some aspects of this heavy rainfall event. Further study with the RTFDDA advanced modeling capabilities, including using ultra-high resolution grid (dx=300m), ensemble prediction capability, a FDDA-WRFVAR hybrid data assimilation scheme, and assimilation of radar radial wind and reflectivity, satellite radiance measurements, and the highly populated surface observation network and other local observation systems, will be conducted to improve the forecast of this event.

Developments and Applications of High Resolution Prediction Systems PART 2 / Développements et applications de systèmes de

prévision à haute résolution PARTIE 2

Room / Endroit (Grand salon B), Chair / Président (Jason Milbrandt), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C3.1 ID:5496 14:00

A new look at the resolution conundrum for mesoscale precipitation forecasts

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The current resolution of operational short to medium range forecasts over North America is on the order of 10 km, while many centers also run real- time forecasts at convective allowing scales (~4km). With continuing increase in computational resources, forecasts at the 1km scale over the continent are becoming feasible. However, research so far has not established any clear advantage of decreasing horizontal grid spacing beyond 4 km. Therefore, the objective of this study is to investigate how having a grid spacing of O(1km) affects the mesoscale capability of the model. More specifically, our goal is to determine how the lack of gain in skill when decreasing grid spacing to 1 km is related to the magnitude of model errors relative to the magnitude of other forecast errors. Furthermore, we attempt to relate the behaviour of model errors caused by model grid spacing to the predictability of the simulated precipitation event. Predictability is defined here in terms of the Lagrangian persistence of the precipitation system, and is measured as the decorrelation time of Lagrangian persistence forecasts produced by MAPLE (McGill Algorithm for Precipitation nowcasting by Lagrangian Extrapolation) as proposed by Germann and Zawadzki (2002). Numerical forecasts are then produced using the WRF-AWR (Weather Research and Forecasting Advanced Weather Research) model at different grid spacing (12km, 4km and 1km) for events of varying predictability. The differences between simulations are then quantified as a function of spatial scale. The scale dependence of model error is then related to the Lagrangian decorrelation time of the precipitation systems. The appropriateness of using the Lagrangian decorrelation time as a proxy for predictability is also briefly discussed.

3C3.2 ID:5398 14:15

Improved quality control and metadata usage in the Real Time Mesoscale Analysis (RTMA) system

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The Real Time Mesoscale Analysis (RTMA) system is one of NCEP’s first products to include the assimilation of mesonet data. This presents a unique quality control challenge, as many mesonet stations are sited in nontraditional environments. This necessitates the gathering of metadata for use in the quality control and data assimilation process. Often, metadata is not readily accessible, but can be inferred by mining observational data. Situational biases can be identified, anticipated, and flagged in real-time by examining observational trends at a particular mesonet site, resulting in a more accurate real-time analysis. This process can also be used to infer or confirm any metadata provided by the mesonet operator. Two examples of data mining and one example of metadata assimilation used to improve the quality of the RTMA analysis will be presented. Statistics calculated with respect to local sun angle are used to identify potential diurnal biases in temperature and moisture observations. A wind binning routine is presented to identify potential obstructions to the flow at or around a mesonet site. Location and mesonet network information are used to ensure that coastal stations are properly assimilated over land as opposed to water. A long term development effort to develop a observation and metadata database system is also described. Utilizing database and data mining technology, other situational biases can be identified, tracked and flagged in real time. Mesonet operators could be notified of potential problems with their stations as they occur, as well. Cooperation between NCEP, local forecast offices and mesonet providers and operators is critical in the development and maintenance of such a system.

3C3.3 ID:5397 14:30

High-Resolution Modeling of Internal Gravity Wave/Cold Pool Interactions over the Complex Terrain of Central Pennsylvania on 14 April 2011

Astrid Suarez [1], *David Stauffer* [1], *Brian Reen* [1], *Brian Gaudet* [1], *Joshua Hoover* [1], *Scott Richardson* [1], *Larry Mahrt* [2], *Nelson Seaman* [1], *Aijun Deng* [1]

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The development and evolution of internal gravity waves and their interactions with surface cold pools are examined through a combined observation and high-resolution modeling study located over the valleys and ridges of central Pennsylvania. Terrain-induced internal gravity waves, often observed over complex topography under clear skies and weakly-forced nocturnal conditions, can contribute to the evolution or even the destruction of valley cold pools. Intermittent bursts of turbulence within the stable boundary layer (SBL) can occur through the modification of momentum and thermal fluxes as well as nonlinear phenomena. These complex interactions contribute to highly variable sub-mesoscale wind and temperature fluctuations (scales < 2000 m) in the SBL. High-resolution (0.444-km horizontal grid spacing, 10 vertical layers in lowest 50 m AGL) Weather Research and Forecasting model (WRF) forecasts are compared to tower and sodar observations from a special data network located at Rock Springs, PA. Daily model forecasts and observations were used to identify cases where calm, clear nights presented wave-like structures. A non-stationary, internal-gravity wave case was observed on 14 April 2011. WRF forecasts suggest that changes in the wind shear and stability profile throughout the night resulted in a characteristic wavelength shortening that impacted the underlying cold pool. The sensitivity of these wave/cold pool interactions to initial conditions / data assimilation and model physics is assessed through a series of nested-grid WRF experiments. The Rock Springs observational data are used to evaluate the accuracy of the forecasts and our understanding of the physical processes.

3C3.4 ID:5738 14:45

The Preliminary Results of High Resolution NCEP GFS by Non-iterative-Dimensional-split Semi-Lagrangian Advection

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A newly-developed semi-Lagrangian scheme has been implemented into NCEP GFS with success. The scheme is different from traditional semi- Lagrangian scheme, it has no need to do iteration to find the trajectory for the advection instead of using the wind at the model grid point. In order to avoid the complication of cell integration for mass conservation, the dimensional splitting in integration of advection is applied. In this case, mass-conservation and positive-definite advection can be easily obtained. This scheme has been implemented into NCEP GFS for all advection terms. There is no specific treatment for

the mass advection due to mountain resonance. All advection are computed in Lagrangian sense, then the changes are applied with other forcing in Eulerian sense as leap frog scheme.

Two resolutions are tried; one is TL878, another one is TL1148. TL878 is the same Gaussian grid resolution as current operational GFS, about 27km. TL1148 is double spectral resolution as compared to operation GFS, and Gaussian grid resolution is about 17km. The preliminary results show that the monthly statistical scores are comparable for south hemisphere, but 0.02 worse than operational GFS over north hemisphere. The tropical score are consistently better than operational GFS. More results will be presented.

3C3.5 ID:5811 15:00

Impact of numerical grid spacing and time step on Vortex Rossby-Waves in secondary eyewall formation in hurricane Wilma (2005)

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Understanding the dynamics of hurricanes is a key to improve their forecast. Recent studies have shown that the formation of the secondary eyewall (SE) and the eyewall replacement cycle affect hurricane intensity change. Numerical models have suggested that Vortex Rossby waves (VRWs) can cause SE genesis when they propagate to the critical radius to interact with the mean flow. However, it is known that the characteristics of the simulated VRWs can be affected by the grid resolution. To determine the effects of horizontal grid length on simulated VRWs during eyewall replacement cycle, numerical experiments of hurricane Wilma (2005) using the WRF model were carried out using varying grid lengths (2,3,4,6 km) and time steps (10,15,20 seconds). The results were analyzed using the method of Empirical Normal Modes (ENM) and the Eliassen-Palm (EP) fluxes and their divergence. The results indicated that the frequencies and the characteristics of the propagating modes are sensitive to the grid length and to a certain extent the time step. The secondary eyewall became absent in coarse resolution runs. Details of the numerical experiments will be presented.

3C3.6 ID:5321 15:15

Automation of the Waterspout Nomogram

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Waterspouts are a known hazard to both the marine and aviation communities. Providing accurate and timely forecasts has always been a challenge for operational meteorologists. More often than not, users are notified of a waterspout event after a report is received. Until recently, no technique existed that allowed operational meteorologists to predict this phenomenon in advance. In 1994, operational meteorologist Wade Szilagyi from the forecast office in Toronto (RCTO) initiated an ongoing intensive investigation on waterspout activity over the Great Lakes. The technique developed, known as the Szilagyi Waterspout Nomogram (Szilagyi 1996), is empirical and based on a large sample of waterspout events which now spans over 17 years. Even though the nomogram has been successfully used by meteorologists for several years now, it is cumbersome especially for forecasters who have a large area of responsibility. Calculations have to be performed manually for points that vary both in space and time. There is a need to automate the nomogram to reduce the diagnosis time for forecasters. In 2011, a computer algorithm was successfully developed to assimilate the above technique to automatically produce a waterspout index field for a specific domain. The algorithm first calculates the water to 850 mb temperature difference and the convective cloud thickness using the GEM Regional model data at each grid point. These two parameters are then matched

with a lookup table, derived from the waterspout nomogram, to determine a corresponding waterspout index. The domain for the algorithm covers the Great Lakes with a grid size of 0.2° latitude x 0.125° longitude. The algorithm has been tested this past summer and results were shown to be satisfactory. Several waterspout events over the Great Lakes will be presented to demonstrate the applicability of the algorithm for waterspout forecasts. Plans for a more sophisticated waterspout prognostic system will also be discussed.

Weather case studies PART 1 / Études de cas météorologiques PARTIE 1

Room / Endroit (Grand salon C), Chair / Président (Rick Danielson), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C2.1 ID:5429 14:00

A preliminary severe winter storms climatology for Missouri from 1960-2010

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Severe winter storms cause significant socioeconomic hardships for the state of Missouri. To date there has not been an all-inclusive climatology on severe winter storms for the entire state of Missouri. This work follows the severe winter storm climatology for Illinois by Changnon et al. (1969) but is updated for Missouri in the years 1960-2010. For a winter storm to be defined as “severe,” it must have produced at least 6 inches of snow, or there had to be enough surface glaze or ice accumulation associated with a storm to cause issues with travel and/or property damage. A mixed storm is defined as a storm that has varying frozen precipitation types, but at least meets one of the aforementioned criteria. From 1960 through 2010, 191 severe winter storms were identified using National Climate Data Center (NCDC) Storm Data Publications. The greatest number of severe winter storms occurred in the month of January with a total of 56. The months of December (52) and February (33) round out the winter. There were 26 (7) spring storms in March (April). There were 1 (16) storms in October (November). The severe winter storms of December and January more often contained a mix of frozen precipitation. Snow was the dominate precipitation type for October- November, February-April. Of the 191 severe winter storms, 80 were storms with snow only, 32 were glaze only storms, and 79 were mixed precipitation storms. Preliminary estimates from NCDC of the financial cost of severe winter storms to the state of Missouri in the last 50 years are between 683 and 831 million dollars (these amounts have not yet been adjusted to 2010 dollars). Cyclone type identification is currently being performed on the 191 storms to determine the dominate cyclone types responsible for severe winter storms in Missouri.

3C2.2 ID:5597 14:15

Revisiting the freezing spray forecast algorithms used in Canada / Une revisite des algorithmes de prévision d’embruns verglaçants utilisés au Canada.

Serge Desjardins [1], *Ted Mcildoon* [2], *Mark Pilon* [2]

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Vessel Icing, or freezing spray, can be explained by two main elements. The first one is the spray flux generated by any relative velocity between the vessel and the moving ocean surface caused by the wave action. The second one is the determination of the percentage of the spray that will freeze on the vessel and the rate at which it will do so. In the past 35 years or so, various freezing spray forecast algorithms were developed to capture either simply, or in a more complex way, the contribution of weather and ocean elements, such as, the surface wind, the air temperature, the sea surface temperature and wave height, that play a role in vessel icing. In the past year, in collaboration with our American colleagues, a project in the National Lab for Marine and Coastal Meteorology has been under way to revisit those algorithms which are more applied for grid point forecast. New displays of the field have been developed to allow a graphical visualization of the results of the algorithms and to allow a comparison between them. Results of this effort, as well as preliminary results from a subjective evaluation done this winter, will be presented.

Le givrage sur les navires, ou embruns verglaçants peut être expliqué par deux principaux éléments. Le premier est le flux d’embruns généré par la vitesse relative entre le navire et la surface de l'océan en mouvement causé par l'action des vagues. Le second est la détermination du pourcentage d’embruns qui gèle sur le navire et le taux auquel se fait ce gel. Au cours des 35 dernières années, divers algorithmes de prévision d’embruns verglaçants ont été développés pour capturer soit tout simplement, ou d'une manière plus complexe, la contribution des éléments météorologiques et océaniques, comme, le vent de surface, la température de l’air, celle de la surface de l’océan, la hauteur des vagues, qui jouent un rôle dans le givrage sur les navires. Depuis la dernière année, en collaboration avec nos collègues américains, un projet dans le laboratoire national de météorologie marine et côtière est en cours pour revoir les algorithmes qui sont plus appliqués, jusqu’à maintenant, pour des prévisions de point de grille. Des nouveaux affichages du champ ont été crée pour permettre une visualisation graphique des résultats des algorithmes et pour permettre une comparaison entre eux. Les résultats de cet effort, ainsi que des résultats préliminaires d'une évaluation subjective effectuée cet hiver, seront présentés.

3C2.3 ID:5684 14:30

The impact of the extra-tropical transition of TC Dale (1996) on the early 1996-97 wintertime stratospheric circulation

Andrea Lang [1], *Jason Cordeira* [2], *Lance Bosart* [1], *Daniel Keyser* [1]
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It has become increasingly accepted that recurving tropical cyclones (TCs) can have substantial impacts on the hemispheric general circulation as well as downstream forecast uncertainty. A recurving TC that transitions into an extropical cyclone can excite a Rossby wave train that is associated with meridional fluxes of heat and momentum. In some cases, meridional fluxes of heat and momentum extend well into the stratosphere, where such fluxes are associated with an upward EP flux from the troposphere into the stratosphere. An environment characterized by EP flux convergence experiences an increase in wave activity and consequently a decrease in the westerly momentum of mean zonal wind. When an extratropical transitioning TC occurs during the spinup of the northern hemisphere wintertime circulation, the impact of the EP flux convergence in the stratosphere can be to slow the establishment of the wintertime stratospheric polar vortex and the associated stratospheric polar night jet.

This talk will explore the hypothesis that the processes associated with the recurvature of TC Dale (1996) were responsible for the weakening of the stratospheric polar vortex. After TC Dale recurved and became extratropical, there was a surge in EP flux from the troposphere to the stratosphere. The EP flux convergence (associated with a decrease in westerly momentum) was located along the flank of the stratospheric polar vortex and was associated with stratospheric ridge amplification over Alaska. The ridge amplification occurred at a point in the season when the stratospheric polar night jet was climatologically spinning up for the winter; however, the flux of wave activity from the troposphere to the stratosphere from recurving TC Dale resulted a weakened stratospheric polar vortex and a substantial departure from climatology.

3C2.4 ID:5775 14:45

The Development of Arctic Air Masses in Northwest Canada

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Northwestern Canada is a genesis region of arctic air masses often considered to be formed primarily through radiative processes. However, the details of their lifecycle are poorly understood. We examine the formation of intense and long-lived arctic air masses, using thermodynamic analyses of surface and rawinsonde observations, along with high-resolution reanalysis data. Such events are characterized by very cold surface temperatures – an average of –42.8°C at Norman Wells, a centrally located station in the formation region – and cooling in the 1000-500 hPa layer. A multistage mechanism for their formation, taking place over 3-days on average, in northwestern Canada is proposed. On the first day of formation, snow falls into a layer of unsaturated air in the lee of the Rocky Mountains, causing moisture increases in the sub-cloud layer. Simultaneously, the mid- troposphere is cooled by cloud-top radiation emissions. On the second day, snowfall abates, the air column dries and clear-sky surface radiational cooling predominates, augmented by the high emissivity of fresh snow cover. The surface temperature falls very rapidly, by as much as 18ºC per day. On the third day, after near-surface temperatures fall below their frost point, ice crystals and, nearer the surface, ice fog form. At the end of formation, there is cold-air damming, with a cold pool and anticyclone in the lee of the Rockies, lower pressure in the Gulf of Alaska and an intense baroclinic zone oriented northwest to southeast along the mountains.

3C2.5 ID:5801 15:00

The thermal trough of western North America

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Although the West Coast thermal trough (WCTT) is the most important mesoscale feature over the U.S. West Coast during the warm season, its initiation, evolution, and structure are not well understood. Often originating in the U.S. Desert Southwest, this inverted trough can extend northward into Oregon, Washington, and British Columbia, with large impacts on temperature, wind, humidity and air quality, and is a critical element for wind energy forecasting during the warm season. WCTTs are most intense near the surface, and their signature weakens rapidly between 800 and 700 hPa. Using NCEP's North American Regional Reanalysis (NARR) dataset, annual and diurnal climatologies of thermal troughs reaching the northwest U.S have been constructed and will be described in this presentation. Compositing of WCTT events is used to describe their synoptic/mesoscale evolution for varying seasons. An examination of high-resolution simulations of individual cases reveals a number of interesting mesoscale features, including

mesoscale plumes of upward motion that accompany thermal trough passage over the Cascade Mountains.

Acoustics in Oceanography / Acoustique et océanographie

Room / Endroit (Symphonie 1), Chair / Président (Len Zedel), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C5.1 ID:5922 INVITED/INVITÉ 14:00

Multifrequency Acoustics for the Classification of Pelagic Organisms

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Effective sampling of organisms throughout the water column has always been a challenge for biological oceanographers and fisheries scientist. The pelagic zone is vast and boundaries are few. Due to their often patchy distribution, fish and zooplankters can exhibit considerable heterogeneity at very large and very small spatial scales, all at the same time. Hydroacoustics continuously sample the whole water column at various spatial scales simultaneously. Multifrequency classification of acoustic backscatter is being applied to an increasing number of taxonomic groups and species, permitting new insights into 3D distributional patterns, density heterogeneity, species behaviour and species interactions. The present talk will summarize the recent application of these techniques to small, medium and large scale ecosystem studies in eastern Canadian waters.

3C5.2 ID:5289 14:30

Tidal and residual currents affect the right whale prey-field distribution on a sloped margin in Roseway Basin

Kimberley Davies , *Tetjana Ross* , *Christopher Taggart*
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Right whales foraging on deep (>100 m) populations of diapausing Calanus spp. in the Roseway Basin Critical Habitat are most often sighted along the southern - southeastern margin of the Basin. We investigated the physical and biological oceanographic characteristics that make this margin a lucrative feeding ground. Bottom-moored Acoustic Doppler Current Profilers equipped with CTDs were deployed across the southeastern slope of the Basin to simultaneously measure variation in Calanus spp., current velocity and water mass characteristics in time and space. Variation in up slope tidal advection of deep basin water with density > 1026 kg m-3 containing a large copepod aggregation was the most important process causing variation in copepod concentrations on the slope. The aggregation was maintained in the slope region through time despite extensive along isobath advection of individual copepods, implying the existence of copepod re-supply mechanisms to the southeastern margin. These could include immigration from surface populations and horizontal transport, as well as gyre re-circulation within the basin. A simple observation-driven model showed that water converges between the 100 and 140 m isobaths on the

southeastern slope and then advects both upward and along the isobath. Convergence coupled with maintenance of the copepods' vertical position through neutral buoyancy could create an accumulation mechanism on the slope, making the area uniquely beneficial to feeding right whales.

3C5.3 ID:5842 14:45

Acoustical Oceanography on a Steep Beach

Alex Hay [1], Len Zedel [2], David Barclay [2], Nina Stark [1]

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Results are reported from an experiment carried out on a very steep (1 in 10 slope) planar gravel beach in a macrotidal (10 m tidal range) environment: the upper Bay of Fundy. The acoustical observations include: (a) turbulence-resolving measurements of the vertical structure of the wave bottom boundary layer and of the velocity of the gravel bed itself with our newly-developed multi-frequency acoustic Doppler profiler, the MFDop; (b) contributions to the ambient noise from ballistic collisions between gravel particles; (c) rotary sonar imagery of the bed; and (d) point measurements of flow velocity within the interior flow well above the bed with acoustic Doppler velocimeters (ADVs). Advantage is taken of the large tidal range and steep beach to obtain measurements both within and outside the surf zone. The presentation will focus on comparisons between the MFDop measurements of apparent bed velocity and the ambient noise spectrum as a function of wave phase both within and outside the surf zone.

3C5.4 ID:5703 15:00

Simulating coherent Doppler backscatter from a moving bottom: measuring bedload transport

David Barclay [1], Len Zedel [1], Alex Hay [2], Nina Stark [2]

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A significant component of sediment transport takes place in the form of bedload, but measuring that component in a field setting is extremely challenging. Instrumentation that attempts to mechanically measure the transport inevitably interferes with the flow. Due to the high concentration of sediment in the ocean bottom boundary layer, optical systems have short operating ranges and therefore must be placed intrusively near the flow. Acoustic systems provide a non-invasive profiling capability in this environment. In particular, Acoustic Doppler Current Profiler (ADCP) based river flow studies have reported evidence of a moving bottom, suggesting that a bedload signal is present. A monostatic and bistatic pulse-to-pulse coherent Doppler model of the acoustic return from a dynamic suspended sediment load, bedload and a stationary bottom is used to investigate the validity of using a wide-band coherent Doppler profiler for field measurements. Results over a range of suspended sediment velocity profiles, independent bedload velocities, bedload layer thicknesses and sediment density profiles are compared. The performance of various configurations of pulse length, pulse frequency and bandwidth in resolving the velocity, backscatter and sediment transport profile is simulated.

3C5.5 ID:5628 15:15

Measuring bedload transport velocity using a prototype wide-band coherent Doppler profiler (MFDop) in the laboratory

Nina Stark [1], Alex Hay [1], Len Zedel [2], David Barclay [2], Richard Cheel [1]

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Bedload transport is a major factor influencing coastline development and seafloor morphology, as well as coastal engineering, e.g., scouring processes at offshore foundations or damage of submerged tidal turbines. There have been a great number of studies investigating bedload transport in the laboratory or using numerical models, but there is a distinct lack of in-situ experiments. This results from the facts that: (i) bedload transport occurs in energetic conditions making the installation of equipment such as samplers difficult; (ii) measuring devices on the seafloor might disturb the bedload transport; (iii) the often small thickness of the bedload layer requires a high vertical resolution in the (sub)millimeter range. Doppler sonar shows great promise for measuring bedload velocity while being sufficient robust for energetic environments without disturbing the bed at the measured position. Here, we present a study testing a prototype wide-band bistatic coherent Doppler profiler (1.2 MHz to 2.3 MHz) for measuring bedload velocity of sandy to gravelly sediments (median grain size: 0.3 – 10 mm). Each sediment group was dispersed along a plane that was lifted up to a range of different degrees of inclination, respectively. Depending on the sediment group and the inclination, the particles started moving and slipped down the plane with a certain velocity. The variation of sediment particle size and sorting, velocity and surface roughness of the plane allowed to test a range of particle dynamics that can be considered similar to bedload transport. The acoustic measurements of bedload velocity and transport are compared to results from simultaneously recorded video particle tracking and the known mass transport of sediment down the inclined plane.

New technologies for weather Services PART 2 / Nouvelles technologies pour les services météorologiques (WAF) PARTIE 2

Room / Endroit (Symphonie 2), Chair / Président (Pat Wong), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C4.1 ID:5829 14:00

The GOES-R Proving Ground: An opportunity for forecasters to shape the satellite products of the future

Ed Szoke [1], *Renate Brummer* [2], *Hiro Gosden* [2], *Steve Miller* [2], *Mark Demaria* [3], *Dan Lindsey* [3], *Deb Molenar* [3]
(Presented by *Edward Szoke*)
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The first launch of the next generation of Geostationary Operational Environmental Satellites (called GOES-R) is scheduled for 2015. GOES-R will not only provide higher resolution imagery at more frequent intervals,

but will also have 16 imager bands, compared to five in the current GOES. This will allow for many potential new products that can be provided to the forecast community. Ensuring that the most useful of these products actually gets into operations when the satellite is launched is a primary task of the GOES-R Proving Ground project. A key to the Proving Ground is bridging the gap between the developers and end users for the purposes of training, product evaluation, and solicitation of user feedback. The project represents a real possibility for forecasters to help determine the products that they will see in the GOES-R era. There are three main Proving Ground partners, the Cooperative Institute for Research of the Atmosphere (CIRA), the Cooperative Institute for Meteorological Satellite Studies (CIMSS) and NASA's Short-term Prediction Research and Transition (SPoRT) Program. These three organizations engage in developing new products that demonstrate the capabilities of the future GOES-R satellites, and testing prototypes with operational forecasters. In this talk we will give an overview of the GOES-R Proving Ground, with a focus on CIRA's efforts, which began over three years ago with interaction with the two closest National Weather Service (NWS) Weather Forecast Offices (WFOs), at Boulder, Colorado and Cheyenne, Wyoming. The effort has expanded to over 15 WFOs and a number of national centers in the U.S. We will address the products being tested, feedback received, and the challenges we have encountered in the area of forecaster feedback, as well as future plans, with an update from the latest GOES-R Proving Ground Annual Meeting scheduled for May 2012.

3C4.2 ID:5562 14:15

Relations Between Total Flash Rate and Radar Reflectivity in Convective Storms

Charlie Liu
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Studies have shown there is a certain relationship between lightning flash rate and radar reflectivity, but the correlations vary due to the weather pattern changes in different regions and seasons. Many of the past studies were based on cloud-to-ground (CG) lightning data, and some studies were based total lightning data from LDAR covering small areas. In this study, we will utilize the total lightning data from the Earth Networks Total Lightning Network (ENTLN) and radar data from the National Weather Service (NWS). We attempt to analyze the relationship between the total lightning data and radar reflectivity for the CONUS and other regions that ENTLN has good coverage. One application from this study is to create a current precipitation map solely based on the total lightning data for regions that lack of radar coverage.

3C4.3 ID:5383 14:30

A UAV PLATFORM FOR THERMODYNAMICAL PROFILES IN THE BOUNDARY LAYER

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Atmospheric profiling of thermodynamical parameters in the boundary layer is important to study physical and dynamical atmospheric processes. Forecasting models benefit from accurate and frequent profiles of temperature (T), dew point T (Td), relative humidity (RH), wind components (Uh and direction), and pressure (P) in the boundary layer. Data assimilation for model initial conditions can possibly be improved through continuous profiles of measurements made by the instruments mounted on UAVs (Unmanned Aerial Vehicles). In this presentation, a UAV platform flying up to 600 m height will be discussed in the content of thermodynamical and meteorological measurements. The Aeryon UAV weighs about 1.5 kg and its maximum payload is of about 500 g. Its flight duration is about 30 minutes and can fly in wind speed up to 85 m s-1. The basic measurements (T, RH, Td, P, and Uh), and future potential of obtaining cloud and fog related parameters and the potential application of validating thermodynamical profiles from remote sensing platforms e.g Radiometrics MP-3000A microwave radiometer and ceilometer (Vaisala CL31) will be discussed.

Renewable Energy – The Important Role of Atmospheric Science PART 1 / Énergie renouvelable : l'importance des sciences de l'atmosphère PARTIE 1

Room / Endroit (Symphonie 3A), Chair / Président (Joël Bédard), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C7.1 ID:5688 14:00

Regional Inter-annual Wind Speed and Wind Production Variability across Canada

Milena Dimitrijevic , *Clint Johnson* , *Josiah Chamberlain* , *Dragan Simjanovski*
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In the majority of project-level debt financing for wind farms, the one-year P99 (99 % probability of exceedence) of production estimate is used to size the debt. The uncertainty in the year-to-year energy output (inter-annual variability), directly related to inter-annual variability in wind speed, is generally the dominant factor in predicting the one-year P99 value. The predicted one-year P99 from the independent wind resource assessment can often make or break the expected returns on a wind farm. Consequently, accurate assessment of the expected inter-annual variation of wind farm energy production, dominated by inter-annual variability in wind speeds, is vital to wind power economics.

Wind farm energy output may vary from year to year due primarily to the natural variability of the wind resource, and also from variation in wind farm availability and other loss factors. The meteorological mechanisms affecting wind resource variability are complex, and, although current assumptions for wind variability are generally robust for the purpose of debt financing, recent studies have suggested that there is no industry-wide consensus on inter-annual variability values. This presentation examines inter-annual wind production variation across Canada and provides observations for regional inter-annual variability values for use in wind resource assessments. Climatic records from several sources are used to derive regional estimates of inter-annual wind speed variability. Using data from operating wind farms, estimates are made for the inter-annual variability of energy loss factors, notably availability. Wind variability and loss factor variability are statistically combined to calculate total inter-annual production variability. Lastly, this approach is tested against observed production variability from operating North American wind farms.

3C7.2 ID:5423 14:15

Estimating uncertainties in multiple wind farm Annual Energy Production (AEP)

Peter Taylor [1], *Jim Salmon* [2]
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Wind farm finance agencies are often concerned about the uncertainty in the prediction of the secure (P90) multi year return on their investments, often from several farms spread across the country. Uncertainties arise from multiple sources, including uncertainties in the estimation of the wind resource, the reliability of turbines and other equipment and climatological variability of annual wind speeds and energy production (AEP). If multiple wind farms are involved, correlation between AEP at different locations will be a factor. A methodology is developed to combine the uncertainties associated with each farm to provide a single uncertainty and multi-year P90 values for an investment in a multi-farm project. It is assumed that most factors are uncorrelated between farms but there may be correlation between annual wind regimes and the wind resource at different sites in any given year. Ten year VORTEX reanalysis wind data for heights of order 100m from a number of locations across Canada show less year-to-year variability (about 3%) than has often been assumed in other uncertainty studies (6%). The latter value is based on an early analysis of UK weather station data at 10m height. As a result estimates of AEP show less year to year variability and spatial correlations may have only a relatively small impact compared to other uncertainties, especially on multi-year P90 estimates.

3C7.3 ID:5771 14:30

Energy production estimate uncertainties associated with missing wind data

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Estimates of the expected Annual Energy Production (AEP) from planned wind farms depend critically on data collected at the site, usually in situ from tall towers but Doppler sodar and lidar measurements can also play a role. The goal of wind monitoring at a given site is usually at least two complete years of data, ideally at the hub height of the proposed turbines, currently these are often in the 80-100 m range. Towers are often shorter than 100m and vertical extrapolation from 60m towers is often required. At many sites data returns greater than 95-98% can be achieved with high quality anemometry, good data loggers and careful monitoring and maintenance. Anemometer icing, dry friction whip on NRG #40 anemometers, power, data logger and communication failures plus human error can however lead to data loss and it is not uncommon to have moderate amounts of data missing when one comes to making AEP estimates. The missing data are often in blocks extending from a few hours to more than 1 week. In that there is a significant annual cycle in wind speed and energy the approach adopted here is to consider the impact of missing data on a month by month basis. Computations of the impact of blocks of missing data on monthly wind speed averages will be presented as a function of the % missing.

3C7.4 ID:5450 14:45

Offshore Wind Resource Assessment in Lake Ontario

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The offshore wind regime east of Toronto in Lake Ontario is being studied by Toronto Hydro, York University

and Zephyr North over the period June, 2010 through July, 2012. This research is important given the current moratorium imposed by the provincial government on all offshore wind farms in Ontario and provides valuable insight into the Lake Ontario wind resource. The Toronto Hydro research platform which is 1.1 km offshore has a lidar measuring wind speed and direction at 6 levels in the lower boundary layer as well as secondary anemometers, pressure, humidity, and temperature instruments at platform level. Lidar is a relatively new way of doing wind resource assessment and special care needs to be taken in the quality control stage. There can sometimes be missing or unreliable levels in the lidar data due to weather conditions or other problems and methods have been developed to “fill” in missing data to create a full accurate data set using secondary instruments. Using a minimum of one year of data a Model - Correlate - Predict (MCP) analysis can be done to predict longer-term wind speeds and energy estimations based on correlations with long term surface wind monitoring stations. There are many methods to do MCP and often several are employed but only those with good correlations are used in the final analysis. These long-term estimations are required by turbine manufactures and institutions providing financing for wind farm projects and are essential for engineering and planning

3C7.5 ID:5639 15:00

Not all speeds are created equal. Investigating the statistical downscaling predictability of historical land surface winds over Central Canada.

Aaron Culver , *Adam Monahan*
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A statistical downscaling approach based on multiple linear-regression is used to investigate the predictability of land surface winds over the Canadian prairies and Ontario. This study's model downscales mid-tropospheric predictors (wind components and speed, temperature, and geopotential height) from reanalysis products to predict historical wind observations at thirty-one airport-based weather surface stations. The model's performance is assessed as a function of: season; geographic location; averaging timescale of the wind statistics; and wind regime, as defined by how variable the vector wind is relative to its mean amplitude.

Despite large differences in predictability characteristics between sites, several systematic results are observed. Consistent with recent studies, a strong anisotropy of predictability for vector quantities is observed, while some components are generally well predicted, others have no predictability. The predictability of mean quantities is greater on shorter averaging timescales. In general, the predictability of the surface wind speeds over the Canadian prairies and Ontario is poor; as is the predictability of sub-averaging timescale variability.

These results and the relative predictability of vector and scalar wind quantities are interpreted with theoretically- and empirically-derived wind speed sensitivities to the resolved and unresolved variability in the vector winds. At most sites, and on longer averaging timescales, the scalar wind quantities are found to be highly sensitive to unresolved variability in the vector winds. These results demonstrate limitations to the statistical downscaling of wind speed and suggest that deterministic models which resolve the short-timescale variability may be necessary for successful predictions.

3C7.6 ID:5538 15:15

Impacts of the tidal power extraction on the sediment transport in the upper Bay of Fundy

Yongsheng Wu , *Jason Chaffey* , *David Greenberg* , *Keir Colbo* , *Peter Smith*
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Impact of the tidal power extraction on the sediment transport in the upper Bay of Fundy has been investigated with a three-dimensional hydrodynamic model, in which the presence of in-stream turbines is simulated by adding an extra term, namely the momentum drag, in the momentum equations. The method looks quite efficient for extracting tidal energy and results are reasonable. In order to understand changes in tidal currents, a series of numerical tests with various arrangements of the turbines, from single turbine to turbine farms, are performed. For tidal regimes, we found that the installation of in-stream turbines can significantly affect tidal flows, however, the effects are mainly limited to the Minas Passage region. The changes in sea level and tidal currents are relatively small. For sediment transport in the presence of the turbines, the model results show that there is less sediment moving into the central Minas Basin. However, more coarse sediment, from southern deep channel of the Minas Passage, moves and deposits in the Southern Bight.

Regional Climate Modelling and Climate Projections PART 5 / Modélisation du climat régional et projections du climat PARTIE 5

Room / Endroit (Ovation), Chair / Président (Anne Frigon), Date (31/05/2012), Time / Heure (14:00 - 15:30)

3C6.1 ID:5593 INVITED/INVITÉ 14:00

Future changes in the European temperature and precipitation climate in an ensemble of Euro-CORDEX regional climate model simulations

Erik Kjellström , *Grigory Nikulin* , *Colin Jones*
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We investigate possible changes in temperature and precipitation on a regional scale over Europe from recent (1961-1990) to future (2011-2040, 2041-2070, 2071-2100) time periods. We use data from an ensemble of regional climate model (RCA4) integrations from the Euro-CORDEX integrations. Here, RCA4 was driven by several coupled atmosphere ocean general circulation models (AOGCMs) under two forcing scenarios, RCP 4.5 and 8.5. The experimental setup allows us to illustrate how uncertainties in future climate change are related to forcing scenario and to forcing AOGCM at different time periods. Further, we investigate the benefit of the higher horizontal resolution, 50 km, in RCA4 by comparing the results to the coarser driving AOGCM data. The significance of the results is investigated by comparing to i) the model simulated natural variability, and, ii) the biases in the control period. The main focus is on changes in the seasonal cycle of temperature and precipitation. We also address changes in higher-order variability including extreme events.

3C6.2 ID:5940 14:30

CanRCM4 and its contribution to CORDEX

John Scinocca , *Slava Kharin* , *Yanjun Jaio* , *Minwei Qian* , *Mike Lazare* , *Greg Flato*

(Presented by *Scinocca John*)
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A collaborative effort between the Canadian Centre for Climate Modelling and Analysis (CCCma) and Recherche Prévision Numérique (RPN) has resulted in 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, which was employed for the Canadian contribution to the IPCC 5th assessment. Novel properties of CanRCM4 include the use of an identical physics package shared between a global and regional climate model, and a new procedure to derive sensible boundary conditions for model-specific tracer variables when driving the RCM with reanalysis data. The performance of CanRCM4 relative to other RCMs is assessed by the reproduction of reanalysis driven NARCCAP simulations. In the application of CanRCM4 for CORDEX, CCCma has focused on the downscaling of its own IPPC contribution. Results are presented for the three CORDEX domains: North America, Africa, and the Arctic.

3C6.3 ID:5378 14:45

CORDEX-Africa climate change projection using the fifth-generation Canadian Regional Climate Model (CRCM5)

René Laprise [1], *Leticia Hernandez-Diaz* [1], *Andrey Martynov* [1], *Laxmi Sushama* [2], *Kossivi Y. Tete* [1], *Katja Winger* [1], *Michel Valin* [1]
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Following the CORDEX experimental protocol, the new fifth-generation Canadian Regional Climate Model (CRCM5) was driven by CanESM2 global model under the RCP4.5 scenario in order to obtain a climate projection for the African continent. Previously, a current-climate simulation performed by CRCM5 driven by ERA-Interim reanalyses was carried out. Here we present preliminary results of a comparison between (a) the two CRCM5 simulations for current climate as well as (b) the two CRCM5 simulations with respect to observations and reanalyses, and finally (c) the climate change signal produced by the nested and driving models.

3C6.4 ID:5335 15:00

Climate and climate change over North America CORDEX domain as simulated by the fifth-generation Canadian Regional Climate Model

Leo Separovic , *Adelina Alexandru* , *René Laprise* , *Andrey Martynov* , *Laxmi Sushama* , *Katja Winger* , *Michel Valin*
Centre ESCER (Centre pour l'étude et la simulation du climat à l'échelle régionale), Montréal
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As a contribution to the COordinated Regional climate Downscaling EXperiment (CORDEX), the ESCER centre carried out two transient climate change simulations with the new fifth-generation Canadian Regional Climate Model (CRCM5) driven by the CanESM2 and HadGEM2-ES global models over the North America CORDEX domain, under the RCP4.5 scenario. The simulations span the period 1950-2100. Previously, a simulation of the current climate was performed with the CRCM5 driven by ERA-interim reanalyses. This presentation will discuss the preliminary results of the CRCM5 simulations over North America. First, the CRCM5 performance will be evaluated by comparing the historical part of the GCM-driven CRCM5 simulations to observations and simulations driven by reanalyses. Next, the CRCM5 performance in

simulating the current climate will be compared to the performance of the driving GCMs. Finally, we will compare the climate change as simulated by the CRCM5 to the climate change projected by the driving GCMs.

3C6.5 ID:5485 15:15

A high-resolution CRCM5 climate simulation over the North America CORDEX domain

Katja Winger [1], *René Laprise* [1], *Andrey Martynov* [1], *Leo Separovic* [1], *Adelina Alexandru* [1], *Bernard Dugas* [2], *Michel Valin* [1], *Laxmi Sushama* [1]

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The COordinated Regional climate Downscaling EXperiment (CORDEX) recommends a resolution of 0.44 deg (about 48 km) for carrying extensive model intercomparaison over several regions of the world. It also suggests making higher resolution simulations for those groups with access to adequate computing resources. The new fifth-generation Canadian Regional Climate Model (CRCM5) developed at the ESCER Centre was integrated at 0.11 deg. (about 12 km), driven by ERA-Interim reanalyses for the period 1989 to 2008 over the North American continent following the CORDEX protocol. Comparing the high-resolution simulated results with observations and with the results of the lower resolution simulation provides an opportunity to identify the added value of running at higher resolution.

POSTER - Unified modelling systems for weather and climate / AFFICHE - Système de modélisation météorologique et climatologique unifié (NWP)

Room / Endroit (Soprano), Chair / Président (Martin Charron), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D1.1 ID:5401 15:30

Impact of mesh refinement on forecasts of the October 2010 extratropical cyclone using MPAS

Laura Fowler , *William Skamarock* , *Joseph Klemp* , *Michael Duda* , *Sang-Hun Park*

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The Model for Prediction Across Scales (MPAS) model is a global non-hydrostatic numerical atmospheric model, specifically designed to produce high-resolution forecasts over regionally-refined areas. MPAS uses unstructured centroidal Voronoi meshes that feature smooth transitions between regions of different spatial resolutions. Smooth mesh transitions ameliorate many problems associated with traditional grid nesting methods. MPAS applications include Climate and Numerical Weather Prediction.

We are testing the performance of the variable resolution mesh on forecasts of the deep extratropical

cyclone that occurred over the United States and Canada in the latter part of October 2010. Observations and model analyses over the Tropical and North Pacific Ocean suggest that deep tropical convection, including the intensification of tropical cyclone Megi to a category 5 typhoon in the Western Pacific on 17 October 2010, contributed to the strengthening of the middle-latitude jet and subsequent intense baroclinic development. We are analyzing the ability of MPAS to predict the position and intensity of the extratropical cyclone as functions of the forecast length and location of the refined mesh, with the goal being to capture the key interactions between the tropical convection and the subsequent mid-latitude synoptic wave.

We have completed three separate forecasts initialized on 15, 19 and 23 October 2010 on a uniform 60-km mesh using re-analyses from the Climate Forecast System Reanalysis (CFSR). MPAS simulated well the location and intensity of the extratropical cyclone over the US for the forecast initialized on 23 October whereas the longer forecasts had major errors in the cyclone intensity and position. The forecast initialized on 15 October was able to simulate rather well the path of typhoon Megi. Our next simulations will focus on the impact of variable higher-resolution meshes to improve the forecast of both events. We will be presenting comparisons of the variable and uniform resolution mesh forecasts.

3D1.2 ID:5425 15:30

Tests of global atmospheric solvers using extensions of the Jablonowski and Williamson baroclinic wave test case

Sang-Hun Park , *William Skamarock* , *Joseph Klemp* , *Laura Fowler* , *Michael Duda*
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During the development of global nonhydrostatic dynamical cores (discrete solvers for the equations of motion without sub-grid scale physics parameterization), it is important to have simple yet comprehensive test flows in order to uncover formulation or coding errors and to assess model performance. We have extended the 3D baroclinic-wave test case of Jablonowski and Williamson by using the most-unstable normal mode of the initial steady-state jet to grow the baroclinic wave as opposed to using an unbalanced perturbation, and we also can optionally include moisture in our initial state. With these extensions we bypass the unbalanced evolution of the original test, we can examine the structure of the normal mode produce by the discrete solvers, and we can directly test the grid-scale forcing arising from the inclusion of moisture in a realistic yet idealized test case.

We have been developing a global model called the Model for Prediction Across Scale (MPAS), which includes both hydrostatic and nonhydrostatic solvers. The solvers use centriodal Voronoi meshes and allow for both uniform and variable-resolution tiling of the sphere. We use the dry test case to verify the correctness of the solver formulation and coding by comparing results from the two solvers and from the global version of the Advanced Research WRF model. The robustness of the solvers are demonstrated by simulating dry and moist baroclinic waves growing from the most-unstable normal mode. When variable resolution meshes are used, the well-known key features of evolving unstable waves are obtained, and these results are quite similar to the results from the quasi-uniform grid. Importantly, the small- scale flow features are well resolved in the fine-resolution region and there is no apparent wave distortion in the fine-to-coarse mesh transition region, thus demonstrating the potential value of MPAS for multiscale flow simulation.

3D1.3 ID:5825 15:30

Unifying modelling components with the scientific workflow: An application of the CRANE framework

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Scientific models often form the basis of management and policy. As decision making tools, they may be coupled with other models, or with model assessment tools to quantify uncertainty and predictive capacity, or to calibrate the model. The combination of these modelling components and the sequence of their operation can be considered a “workflow”.

A “scientific workflow” is a method of decomposing a complex problem into a sequence of components that can be evaluated individually. In the context of simulation modelling, these components may be statistical tools, pre- or post-modelled analyses, calibration tools, or other models and modelling components. Quite often, the components are not interoperable, having incompatible code, independent interfaces, or unique standards for input and output.

CRANE is a model-independent framework to address these difficulties via an interface that can be linked with modelling components using human-readable XML (extensible markup language). CRANE provides an intuitive graphical environment for model configuration, parameter validation, and execution of the workflow. It uses simple definitions of modelling components (e.g. a model has “input”, “observations”, “parameters” and “output”) to provide interoperability (e.g. a calibration exercise can manipulate “input” by modifying “parameters”, and measure progress by comparing “output” to “observations”).

CRANE was used to link the MESH (“Modélisation environnementale de la surface et de l’hydrologie”) land-surface hydrology modelling system with OSTRICH (Optimization Software Tool for Research in Computational Heuristics), an optimization code. MESH uses land surface data and meteorological input to predict stream flow and soil moisture, among other variables. A workflow was designed to compare the performance of an updated frozen soil infiltration algorithm to existing code in MESH, through a calibration performed by OSTRICH. CRANE provided visualization of the results. The response of the modelled stream flow was improved by the updated frozen soil infiltration algorithm.

3D1.4 ID:5355 15:30

Preliminary Numerical Testing of Conformal Spherical Grids

Miodrag Rancic [1], *R. James Purser* [1], *Bojan Kasic* [2]
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Quasi-uniform gridding of the sphere, resulting in a various spherical polyhedrons, got a significant attention in the last two decades as a method to save memory and increase computational efficiency of the global models of the atmosphere. One arguable drawback of this approach was that virtually all attempts to cover the sphere with smooth and continuous quasi-uniform coordinates require a transition to a general curvilinear formulation of the governing equations, which generally interferes with a straightforward transition of operational global models, or globalization of the regional models, into these grid geometries. An alternative approach is to allow a small overlapping at the corners of the spherical polyhedron, which leads to the possibility for orthogonal, even conformal, mapping of the sphere, but includes need for blending solutions at the overlapping areas. A more elaborate paper addressing derivation and geometrical aspects of such grids will be presented elsewhere at this Conference. This presentation addresses simple test results serving as a preliminary evaluation of this mapping strategy, and investigates various options for preserving global conservations on such a ‘conformal sphere’.

POSTER - Developments and Applications of High Resolution Prediction Systems / AFFICHE - Développements et applications de systèmes de prévision à haute résolution

Room / Endroit (Soprano), Chair / Président (Jason Milbrandt), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D2.1 ID:5694 15:30

Procedures for mapping high-resolution numerical weather prediction model output with radar observations over complex terrain

Ruping Mo [1], Paul Joe [2], Jason Milbrandt [3]

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Radar observations and high-resolution numerical weather prediction (NWP) model guidance played crucial roles in supporting the weather services for the Vancouver 2010 Olympic and Paralympic Winter Games held in southwestern British Columbia, Canada. In particular, a special C-band Doppler radar installed near Whistler provided the critical real-time information of the detailed atmospheric conditions in a mountainous area for the forecasting operations. This radar also captured a variety of unusual orographic flow patterns that could be better understood through a further analysis of high-resolution NWP model output, if these patterns were correctly predicted by the model.

To facilitate such a radar interpretation-model validation approach, this study presents some practical procedures to derive equivalent radar observations from the hydrometeor properties predicted by a cloud-resolving NWP model. These procedures consist of two principal components: mimicking the radar-detected hydrometeor properties based on the available NWP variables and presenting the equivalent reflectivity and radial velocity on either PPI (Plan Position Indicator) or RHI (Range Height Indicator) display. Their usefulness as a set of tools to interpret radar observations and validate high-resolution model predictions over complex terrain is demonstrated through a case study of the orographic influence on a Pacific winter storm across the Whistler area in 2010. Their potential application to mesoscale assimilation of radar data for improving high-resolution NWP is also outlined in this study.

3D2.2 ID:5347 15:30

Effects of Reconnaissance Flight Data on Data Assimilation and Numerical Simulation of Tropical Cyclones over South China Sea

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The Hong Kong Observatory (HKO) and the Government Flying Service (GFS) of the Hong Kong Government conducted reconnaissance data collection flights in 2011 for two tropical cyclones (TCs) over the South Chin Sea. It was the first time in the region to carry out this kind of measurements specifically for TCs. The flight observations provided high temporal resolution of data at 20 times per second to depict the wind flow and meteorological conditions. They were found to be consistent with other synoptic station data sparsely located over the sea areas, as well as in good agreement with the ocean winds from satellite microwave scatterometer. In this study, the aircraft measurements taken from the data collection flights for the two TCs in 2011 and another case conducted in July 2009 were assimilated into the HKO Non-Hydrostatic Model with its three-dimensional variational data assimilation (3DVAR) to investigate the effect of the data in the model analysis and forecast. Model sensitivity runs were conducted to show the impacts of flight measurements in 3DVAR analysis of wind, temperature and relative humidity. It was found that the flight data can improve analysis and forecasts of wind circulation, temperature and humidity in the vicinity of the storms. Benefits in track forecasts are obtained through the use of the flight measurements, although insignificant effect is seen in the forecast of central pressure. Additionally, the data assimilation of flight measurements shows positive effects in forecasting wind distribution and precipitation associated with the TCs.

3D2.3 ID:5809 15:30

Impact of vortex Rossby waves on the structure and intensity change of hurricanes: two-dimensional eyewall-like ring of enhanced vorticity in the formation of the concentric eyewall and secondary wind maximum

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The mechanism responsible for the formation of concentric eyewall frequently observed in intense hurricanes still remains an open question. In this study a simple two-dimensional unforced barotropic nondivergent model is used to simulate the formation of eyewall-like concentric rings of enhanced vorticity. The theory of empirical normal modes (ENM) together with the Eliassen-Palm (EP) theorem is used to isolate the dominant wave modes and study their impact on the structure and intensity change of the simulated vortex. The results indicate that the leading modes exhibit mainly characteristics of “discrete-like” vortex Rossby waves. The critical radius and structure of some of these leading modes are found to be consistent with the quasimodal structures from linear eigenmode analysis. The fact that the critical radius is located close to the region where the secondary wind maximum develops support the notion that vortex Rossby wave dynamics are essential for concentric eyewall formation.

POSTER - Land-surface processes (NWP) / AFFICHE -Processus de surface terrestre (NWP)

Room / Endroit (Soprano), Chair / Président (Stéphane Bélair), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D401.1 ID:5665 15:30

Closing the land surface water balance: The use of an approximation of Richard’s Equation to convert distributed soil moisture into streamflow

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Sub-grid lateral flow is among the most poorly parameterized processes in hydrologic modeling. The physics are well represented by the Richard’s Equation, which is essentially the mass and energy balance for flow through a soil matrix. Modelers 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 hydrological modelling also require the distribution of retained soil moisture at the surface.

An approach is being developed 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 of the numerical solution.

The resulting storage-discharge curves are well approximated by a power law. This vindicates the use of the traditional system characteristic curve for interflow, Q = Q0•[(S- SR)/(SC-SG)]D. Furthermore, by comparisons with the analytic solution, coefficients for the curves can be defined a priori from soil and topographic information.

The theory has been extended to demonstrate the solution approaches exactness for saturated flow conditions for all slopes and for all flow conditions for long slopes. The primary advantage of this method is the more accurate representation of basin storage with the result that the recession curves are more realistic. Nash-Sutcliffe coefficients for simulations of four South Saskatchewan River basins have improved from values around 0.5 to 0.8.

3D401.2 ID:5546 15:30

Using an artificial neural network to estimate snow depth in the Colorado Rocky Mountains

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Past research has explored the relationship between various snow free topographic parameters and peak snow depth. Parameters such as slope, aspect, elevation, and sheltering indices have shown ability to predict snow depth distributions over various basins throughout the world. Little work has been done in the context of using artificial neural networks to produce snow depth estimates based on terrain parameters. In this study, various artificial neural network configurations are explored using varying topographic parameters

to determine the optimal network configuration. The network is then applied to several different areas and validated against LIDAR snow depth measurements. Improved estimation of snow depth can benefit high resolution numerical weather prediction through improved lower boundary conditions/input to land-surface models.

POSTER - Data Assimilation and Predictability / AFFICHE -Assimilation de données et prédicibilité (NWP)

Room / Endroit (Soprano), Chair / Président (H. Mitchell, Z. Pu and C. Reynolds), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D3.1 ID:5800 15:30

CMAM20: Simplified data assimilation in the extended CMAM.

Stephen Beagley , *Victor Fomichev* , *Kirill Semeniuk* , *Marianna Shepherd* , *Jack Mcconnell*
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The Extended CMAM is currently being run in a forecast mode allowing the use of the model to simulate specific events. The current analysis period covers 1990-2010. The model is forced using ERA-Interim re-analyses via a nudging technique for the troposphere/stratosphere in combination with the GCM evolution in the lower atmosphere, ERA-Interim re-analyses being merged with the model. Thus a transient forced model state is created and the upper atmosphere is allowed to evolve in response to the observed conditions occurring in the lower atmosphere and in response to modelled boundary conditions and other transient forcings such as SSTs, solar flux conditions and chemical constituent changes. This methodology allows specific events and observations to be more successfully compared with the model. Work will be presented on several projects including HEPPA(2008-2009), IPY (2005-2006) and WINDII comparisons (1991-1995) where the forecast mode allows a better representation of specific dynamical events (“weather”) during particular instrument measurement campaigns.

3D3.2 ID:5722 15:30

Joint OSSE data set

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An internationally collaborative effort for Observing System Simulation Experiments, called Joint OSSE, was formed during past several years. OSSEs which allow the quantitative assessment of the analysis and

forecast impact is called Full OSSEs.

Providing Nature Run, truth for OSSE, must be produced by the state of the art forecast model. The first Joint OSSE Nature Run was produced by the European Center for Medium-Range Weather Forecasts (ECMWF). This Nature Run covers a 13 month period at T511 horizontal resolution with 91 vertical levels in 2006. A new Nature Run with higher resolution with improved model is being considered.

In a Full OSSE, all major observations used for the data assimilation have to be simulated as a control observation in addition to the observations to be tested by OSSEs. Simulation of control observations and OSSE calibration are the most significant initial investments for a full OSSE before it can be used to evaluate data impact of future instruments. NCEP and NESDIS volunteered to simulate control observations.

Simulated data and a data base for alternative simulations for 2005-2006 observing system have been prepared. Entire period of radiance data were simulated using CRTM1.2.2 and saved in BUFR format for entire Nature run period. Conventional data were also simulated and posted with real observation. No observational error added to the data set. Users are expected to add observational error.

3D3.3 ID:5662 15:30

Enhancing atmospheric river forecast-verification through the use of multiple domain sizes with DTC's MET/MODE object analysis utility

Wallace Clark [1], *Edward Tollerud* [2], *Tara Jensen* [3], *Gary Wick* [4], *Ellen Sukovich* [4], *Huiling Yuan* [5], *Randy Bullock* [3], *John Halley Gotway* [3], *Tressa Fowler* [3]

(Presented by *Tressa Fowler*)

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Object analysis (via DTC's MET/MODE utility) of atmospheric integrated water vapor (IWV) and water vapor flux (IVT) fields makes it possible to identify and associate space, time, and intensity attributes to important features (here atmospheric rivers, or ARs) within the gridded data fields. With respect to ARs, this object identification capability relates closely with the forecasting of extreme precipitation events along the North American West Coast. Since the IWV and IVT fields associated with landfalling ARs are generally synoptic scale or larger while the coastal precipitation events are nearer mesoscale or even smaller there is an inherent analytical need to treat various aspects of the forecast verification using differently scaled domains. MODE has, built into it, the capability for the user to carve out a smaller, purpose designed domain from the larger initial input domain. Thus, verification across the scales may be accomplished by using multiple MODE passes and combining the results. Obviously, the information provided by the analysis at the different scales highlight different aspects of the verification. For example, the MODE attributes found using the full Northeast Pacific domain allow a meaningful comparison of GFS IWV forecast fields versus those observed by satellite (SSMIS), while MODE analysis over a narrow coastal strip domain allows objective identification of actual landfall events, with specification of their location and intensity. Finally, in an intermediate near coast domain severe truncation of the synoptic scale objects makes direct use of the MODE attributes difficult to interpret, although with case by case inspection biases in location and timing may be inferred. A difficulty with the forecast data sets used in this study was the 12 hour spacing of 'snapshot' GFS model output. While adequate using the full Northeast Pacific domain to compare GFS IWV fields with 12 h composite satellite (SSMIS) observations, in the longitudinally thin coastal strip domain the 12 h time gaps

prevented clear analysis of event duration, intensity over time, and track. More frequent snapshots (i.e., model output on the order of hourly) would alleviate this problem at the expense of increasing storage by a factor of 12. Alternatively, if the model output was modified to include accumulations of IWV or IVT, similar to the accumulations over time used with precipitation verification, this would improve the representativeness of the approach, but at the expense of space and time resolution.

3D3.4 ID:5504 15:30

Nonlinear Characteristics of Ensemble Perturbation Evolution for Land-Falling North American Midlatitude Cyclones

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Nonlinear perturbation evolution within an ensemble Kalman filter data assimilation/forecasting system can play a significant role in the nature of ensemble mean forecasts. Considering ensemble perturbations about a mean initial condition, mostly linear evolution essentially places the mean on the model attractor, indicating a realistic solution. As perturbation evolution becomes more nonlinear, mean forecasts can diverge from the model attractor, demonstrating unrealistic behavior despite relatively good verification scores. This study examines this behavior for land-falling mid-latitude cyclones on the west coast of North America. Specifically, this work aims to gain an understanding of how quickly mean forecasts diverge from a forecast begun from the mean analysis for these cyclones, which provides a unique measure of nonlinearity. Furthermore, ways to select members closest to the mean will be explored that ideally provide both good verification scores and realistic solutions.

3D3.5 ID:5592 15:30

The predictability of tropical cyclone genesis in regional ensemble forecasting: case studies with two computationally efficient perturbation methods

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Considering the lack of observations over the oceans, analyses of tropical cyclone (TC) environments have long been error-prone. Various methods have thus arisen to perturb initial conditions and create ensembles that attempt to best describe the forecast probability distribution. The objective of this study is to examine the effectiveness of two separate styles of computationally efficient perturbation methods, the fixed covariance perturbation method (FCP) and the breeding vector method, in their ability to generate reasonable initial perturbations for ensemble forecasting of tropical cyclone genesis. The Weather Research and Forecasting model (WRF) is used in the investigation. The error growth characteristics, genesis statistics, and critical environmental fields (of moisture, heat, etc) of two developing TCs (e.g., Ernesto (2006) over the Atlantic Ocean and Nuri (2008) over the Pacific Ocean) are studied using the two perturbation methods. Specifically, the breeding vector method is studied with different cycling configurations (i.e., every 3 or 6 hours). The breeding and FCP methods will be compared in terms of their perturbation versus error correlation analysis (PECA) statistics and their ability to produce an accurate ensemble mean, forecast realistic ensemble spread, and create reasonable statistics in terms of accurately forecasting TC genesis and avoiding false alarms.

3D3.6 ID:5469 15:30

Improving the Canadian Precipitation Analysis (CaPA) on the Nelson River watershed through data assimilation of remotely sensed observations of precipitation provided by

PERSIANN

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The Canadian Precipitation Analysis (CaPA) is a new operational product available from the Meteorological Service of Canada, which combines observations from precipitation gauges with a background field provided by the regional deterministic prediction system (RDPS), itself based on the GEM model. In order to improve the product over the Nelson River watershed, which drains most of the Canadian Prairies, an experimental version of CaPA has been set up as part of a collaborative research project between Environment Canada, the University of Manitoba, and Manitoba Hydro. This configuration of CaPA assimilates additional gauge data provided by provincial departments and agencies, as well as a remote sensing product, PERSIANN, which estimates precipitation from infrared GOES imagery. It is shown that the addition of PERSIANN as an observation source leads to a significant improvement in the skill of CaPA during the afternoon in summer. Furthermore, a similar level of skill is obtained when using PERSIANN as the background field, opening the possibility of developing an analysis which is independent of the GEM model, and which hence could be better suited for the verification of short-term GEM forecasts.

3D3.7 ID:5438 15:30

Case study for tropical storm initialization and data impact using the HWRF and GSI system

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The improvements of hurricane initialization have become a top priority in both the research and operational communities. These improvements must come about primarily through increased data availability, but also through better analysis methodologies. The main objectives of this work are i) to investigate the near-operational hurricane WRF (HWRF) system configurations and evaluate their performance, ii) to assess the impact of Global Positioning System (GPS) radio occultation data in a variety of data assimilation experiments using NCEP’s Gridpoint Statistical Interpolation (GSI) three-dimensional variational (3D-Var) data assimilation performed for selected tropical cyclone cases, ii) to investigate how to improve hurricane forecasts by assimilating additional satellite observations. In order to make use of expanded observations, advanced data assimilation techniques, if available, will also be explored e.g., a hybrid variational-ensemble method to enable the existing GSI data assimilation system to use the flow-dependent background error statistics. Retrospective cases will be run and preliminary results will be presented.

3D3.8 ID:5367 15:30

Assimilating HDOB data in COAMPS® NAVDAS for Hurricane Earl

Dan Tyndall [1], *Patrica Pauley* [2], *Nancy Baker* [2], *Heather Holbach* [3], *Keith Sashegyi* [2], *Clark Amerault* [2], *Rolf Langland* [2]
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High Density Observation (HDOB) data provide flight level in-situ observations of temperature, dewpoint, wind speed and direction, as well as surface observations of maximum wind speed and rain rate derived by the Stepped Frequency Microwave Radiometer (SFMR). HDOB data are high quality, high density observations collected by NOAA and USAF hurricane reconnaissance aircraft with 30 second averages for in-situ observations and 10 second averages for remotely-sensed observations.

The impact of HDOB data on hurricane forecasts is determined through numerical experiments using the NRL Atmospheric Variational Data Assimilation System (NAVDAS) and the Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS®). The numerical experiment is set up to forecast the track and intensity of Hurricane Earl from the 2010 hurricane season. Experimental runs that include in-situ flight level and SFMR derived surface HDOB data are compared against control runs without the additional HDOB data. Preliminary results show that usage of flight level HDOB data is beneficial in reducing Hurricane Earl's track and central pressure forecast errors, as verified by the best track data provided by the National Hurricane Center.

3D3.9 ID:5764 15:30

Impact of Pacific Typhoons on Midlatitude predictability

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The impact of North Pacific typhoons on the predictability of synoptic scale flow over the northern hemisphere midlatitudes is diagnosed. The primary dataset used is a long-term suite of ensembles of reforecasts. Spatio-temporal characteristics of forecasts errors are examined and compared with climatological forecast errors in the same suite of ensembles.

POSTER - Satellite data assimilation in global or regional weather prediction systems (NWP) / AFFICHE -Assimilation d'observations satellitaires pour les prévisions météorologiques globales ou régionales (NWP)

Room / Endroit (Soprano), Chair / Président (Louis Garand), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D4.1 ID:5573 15:30

Assimilation of synthetic aperture radar wind information in Environment Canada's limited-area analysis system

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Challenges of incorporating a new observational platform into a weather forecast system include there being more data to assimilate and the observational weighting being unclear, with observed scales and physical processes being incompletely resolved as well. Satellite synthetic aperture radar (SAR) has the potential to provide O[1-km] ocean wind, current, and possibly wave breaking information, but an initial simplification is to interpret SAR backscatter following established methods of scatterometer wind retrieval. This motivates our study, although we have so far treated SAR observations following an approach that is both direct (i.e., that assimilates backscatter instead of derived wind) and inclusive of smaller scales (i.e., that strives to benefit from scales unresolved by more conventional observing platforms). The integration of SAR data into ongoing developments of high resolution data assimilation at Environment Canada is introduced. Some 60 assimilation periods between 10 November and 20 December, 2009 are employed to summarize the impact of SAR assimilation on analyses.

3D4.2 ID:5353 15:30

Improving Cloud and Moisture Representation by Assimilating GOES Sounder Products into Analyses for NWP

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Adequately forecasting moist processes resulting from mesoscale and synoptic weather system dynamics is an active problem in the realm of operational meteorology. Numerical weather prediction has been a beneficial tool for studying and forecasting such processes. A number of parameterizations have been developed to facilitate the solution while suppressing numerical instabilities and controlling budgets of conserved quantities. However, the ideal model must be initialized with an analysis that adequately resolves variations in the moisture concentration and cloud cover on the same scale as the simulation grid spacing to attain the most accurate forecast. Due to a very sparse upper-air observation network across the United States, the only way to accomplish this is with satellite products.

A methodology has been developed for an experiment with several parallel regional Weather Research and Forecasting (WRF) model simulations initialized with satellite-based retrievals. The intent is to clarify the impact of observations, in the form of retrievals, from the Geostationary Operational Environmental Satellite (GOES) Sounder on 12, 24, and 36-hour WRF model forecasts of precipitable water, low-level relative humidity, precipitation, and sky cover. Two experimental analyses are built from a CIMSS Regional Assimilation System (CRAS) pre-forecast spin-up. The CRAS assimilates precipitable water and cloud products derived from the GOES Sounder. An experimentation period between late September and early October 2011 found that the majority of impact in the experimental simulations compared to the control is recognized in the total precipitable water field over the first 12 hours. In some cases, this resulted in an improved precipitation forecast. Cloud cover results were inconclusive, though a new technique developed for use in the CRAS outperformed the current WRF cloud fraction approach.

POSTER - Weather case studies / AFFICHE - Études de cas météorologiques

Room / Endroit (Soprano), Chair / Président (John R. Gyakum), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D5.1 ID:5720 15:30

On Precipitation Production at Cypress Mountain

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Cypress Mountain, situated just north of Vancouver, represents a typical coastal barrier for moisture-laden onshore airflow and therefore is subjected to large amounts of precipitation. The athletic events at this site (snowboarding and freestyle skiing) during the 2010 Vancouver Olympic Winter Games were plagued by postponements and delays due to the lack of snow. A great deal of rain occurred, however. Unprecedented information on precipitating systems affecting this mountain was obtained as part of SNOW-V10 (Science and Nowcasting Olympic Weather for Vancouver 2010). This includes sensors such as the Micro Rain Radar (MRR), Precipitation Occurrence Sensor System (POSS) and enhanced surface weather stations, as well as operational radar and satellite data. Utilizing this data, the objective of this study is to quantify the means through which precipitation is produced on this barrier paying particular attention to the transition regions between rain and snow. Some precipitation events lasted upwards of 24 hours although moderate to heavy rates only lasted to a maximum of approximately 6 hours. Vertical radar profiles revealed the common occurrence of precipitation aloft and the increase in intensity down towards the surface (observed by rapid increases in fall velocities and reflectivity at the melting layer). Inferred locations of the melting layer aloft just upwind of the barrier were compared with the actual heights observed on the mountain; the transition on the barrier was sometimes at a distinctly different height. These and other observations will be shown in the presentation. This study has important implications for assessing the exact means through which precipitation is produced on the coastal range during El Niño conditions, and it also has implications for improved nowcasting and forecasting.

3D5.2 ID:5555 15:30

Effects of microphysical processes on the wind fields over complex terrain during the Vancouver 2010 Winter Olympics

Julie Thériault [1], *Jason Milbrandt* [2], *Ruping Mo* [2]

(Presented by *Julie Theriault*)

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Weather forecasting on the coast of British Columbia is a great challenge because of the complex terrain and the maritime environment leading to temperatures near-0°C in the wintertime. During the Vancouver 2010 Winter Olympics on 14 February, a rapid cooling associated with precipitation was observed at instrument sites in the Whistler, BC, area. This was followed by the formation of a near-0°C isothermal layer and a shift of the airflow from up- valley to down-valley. The goal of this study is to quantify the relative effects of microphysical processes and warm air advection on the surface precipitation and the low-level

flow. Sensitivity tests were conducted to determine the relative impacts of diabatic cooling of melting snow, sublimation, evaporation, and warm air advection on the flow reversal in the valley. In addition, results using an approach to improve the representation of partially melted snow without the need for any additional prognostic variables will be illustrated. Overall, this study demonstrates the importance of accurately simulating phase changes during winter weather events in complex terrain when the temperature is near-0°C.

POSTER - Decision Support Meteorology (WAF) / AFFICHE -Météorologie en support à la prise de décision (WAF)

Room / Endroit (Soprano), Chair / Président (Alex Tardy), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D402.1 ID:5342 15:30

Environnement Canada dans votre poche

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Le serveur de données d'Environnement Canada, nommé Datamart, est déjà connu pour les services qu'il offre aux usagers spécialisés dans différents domaines.

Une facette émergente du Datamart concerne la distribution indirecte d'information météorologique à l'aide de logiciels et d'applications déployés sur différentes plateformes, notamment les téléphones mobiles (iPhone, Blackberry, Androïd).

Faites un survol de données disponibles et découvrez comment il est simple de les intégrer dans une application développée à la maison.

3D402.2 ID:5719 15:30

Generating automated TAFs from a numerical weather prediction system

Todd Hutchinson , *Cathryn Meyer*
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A procedure that utilizes output from a locally run numerical weather prediction (NWP) system to derive automated terminal aerodrome forecasts (TAFs) is presented here. The automated TAFs are provided to forecasters to use as guidance in generating TAFs for aviation clients.

The NWP system is based upon the Weather Research and Forecast modeling system (WRF). It is run operationally at resolutions ranging from 4km over the contiguous United States (CONUS) and Europe to 36 km nearly globally to produce forecasts out to 72 hours. Forecasts are updated every 3 hours over CONUS and every 6 hours outside of CONUS. Gridded forecasts from the NWP system are processed into fields required for the production of TAFs, including surface weather, precipitation intensity, ceiling, visibility and surface wind, then interpolated to airport locations. The interpolated output is then corrected using current airport conditions, formatted and presented to forecasters as a first-guess TAF.

The techniques used to generate the automated TAF forecasts will be presented. Further, skill of forecasting flight rule categories (e.g., VFR, IFR) using the automated TAFs at over 30 sites over the past year will be shown.

3D402.3 ID:5672 15:30

Applications of the Canadian Precipitation Analysis (CaPA) in Agriculture

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The Canadian Precipitation Analysis (CaPA) is an assimilated precipitation product developed and distributed by Environment Canada that combines NWP (GEM REG) precipitation prognosis with in-situ observations resulting in a 15km gridded estimate of 06 and 24 hour liquid water equivalent precipitation accumulation. Since becoming operational, CaPA is now used by Agriculture and Agri-Food Canada (AAFC).

The National Agroclimate Information Service conducts a daily Qa/Qc procedure on in-situ station data from several sources. The Qa/Qc procedure uses a statistical based approach using adjacent in-situ stations for gap filling missing data. CaPA estimates have been incorporated into the process to help validate the data and as an alternative source for gap filling.

CaPA has the potential to generate complete temporal records, and subsequently increase the spatial network density, which are vital for the calculation of drought indices - Palmer Drought Severity Index, Soil Moisture Anomalies and the Standardized Precipitation Index. These indices and their derivatives are then fed into the Government of Canada program related activities such as Livestock Tax Deferral and the North American Drought Monitor. These indices are also being used in decision support tools such as the Canadian Crop Yield Forecaster. Work on CaPA derived user-friendly web map products has started and will be offered to agricultural stakeholders of Quebec and the Atlantic regions on a pilot basis. Potential use of CaPA is also being considered for applications such as crop disease risks monitoring and forecasting, irrigation planning, nitrogen management and agricultural risk management.

POSTER - New technologies for weather Services / AFFICHE -Nouvelles technologies pour les services météorologiques (WAF)

Room / Endroit (Soprano), Chair / Président (Edward Szoke), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D6.1 ID:5509 15:30

On the observational capabilities of a scanning millimeter-wavelength cloud radar: 3D marine stratocumulus cloud and drizzle observations at Graciosa Island, Azores

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An accurate characterization of the 3D structures and inhomogeneities of marine stratocumulus clouds over an extended horizontal plane is essential for understanding their radiative properties for applications to Global Climate Models. These structures and inhomogeneities have, for the first time, been observed in 3D using the U.S. Department of Energy (DOE) Atmospheric Radiative Measurement (ARM) program’s Scanning W-Band ARM Cloud Radar (SWACR) at Graciosa Island, Azores in November 2009. The use of a scanning radar signifies an important change in how cloud radars observe the atmosphere, shifting from a multi-instrument vertically pointing ‘soda straw’ view to a scanning ‘radar centric’ view. Observations were made utilizing an RHI scanning strategy designed to best sample and recreate 3D cloud structures. The raw measurements are quality-controlled using a significant detection algorithm, and water vapour attenuation corrections are applied. The measurements are then gridded into a 3D Cartesian coordinate domain using an adaptive gridding algorithm, resulting in 3D gridded domains of radar observables. Although the radar showed excellent sensitivity (-42.5 dBZ at 1 km), the reduction in sensitivity with range from the radar hindered the ability to accurately resolve cloud boundaries, resulting in an artificial thinning of clouds at range, and an inability to detect drizzle-free cloud structures beyond 5 km from the radar. However, clouds containing drizzle were detectable at ranges up to 10 km, and despite an artificial thinning offered significant insight into the overall structure of the cloud field. Furthermore, several instances of organized streaks in the drizzle field (reflectivity greater than -15 dBZ) are observed to be embedded in the cloud field. These streaks are hypothesized to be boundary layer rolls, and observed atmospheric conditions (sub-cloud level winds and shear) support the existence of these rolls in most instances.

3D6.2 ID:5318 15:30

Satellite Image Enhancement in a High Performance Forecast Workstation – NinJo – for Canadian Forecast Applications

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A high performance forecast workstation called NinJo has been developed jointly by Germany, Denmark, Switzerland and Canada. It is highly configurable and can be customized for specific applications for any geographical domain. The first version of NinJo was released in 2009 for operational use in Canadian weather offices. Ninjo’s multi-window technology, layer-based visualization technique, flexible client/server architecture and high degree of configurability make it a very robust platform for viewing and analyzing different geographical and meteorological data in a single window interface. Users can also construct and save “scenes or sessions” consisting of different layers of data for specific forecast applications. This one-stop multiple data importing and displaying architecture provides an effective way for operational forecasters to perform daily weather monitoring and to produce forecasts and warnings. Weather monitoring using satellite data is critical in Canada because of its limited observation and radar network coverage over much of the country. The satellite component in NinJo provides an effective platform to display various enhanced satellite images and derived products from different channels and sensors (GOES, POES, and MODIS, etc).

Visualization of the imagery is controlled by built-in functions including color enhancements, alpha bending, pixel histograms, gamma correction factor, multi-spectral RGB imaging, and product importer. Other data such as surface observations, radar images, winds, and NWP model fields can be overlaid on the satellite layers to provide a composite view of the weather process. All satellite data are automatically updated and stored in the data server for 10 days. These capabilities also make NinJo a good learning and research tool for post event analysis. In this poster presentation, the data inflow and display architecture for the satellite component in NinJo will be outlined and functionalities for image visualization will be described. Examples of single channel, multi-spectral RGB, and specialized products for various forecast applications will be presented.

3D6.3 ID:5792 15:30

Canadian Lightning Detection Network Communications Upgrade

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The Canadian Lightning Detection Network (CLDN) is composed of 84 sensors of three different types; LPATS IV (11), the IMPACT (23) and the LS7000 series (50). Due to recent changes in satellite communications providers the MSC experimented with alternate technologies (DSL, cellular modems, IRIDIUM, other satellite service providers, etc.) with varying degrees of success. As not all of the service options are available at all locations, we were forced to accept that the CLDN would be a blended network with respect communications technologies. This session will showcase the improvements Environment Canada has made, and will make, to lightning detection monitoring in Canada. The discussion will centre on how we arrived at the current solution for communications and the relative strengths and weaknesses of each alternative technology investigated vs. cost effectiveness.

POSTER - Risk Communication and Meteorology: Interdisciplinary strategies and approaches to mitigate impacts / AFFICHE -Communication des risques et météorologie : stratégies et méthodes interdisciplinaires pour atténuer les impacts

Room / Endroit (Soprano), Chair / Président (Rebecca Wagner), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D403.1 ID:5661 15:30

Surface Temperatures: A Significant but Largely Unrecognized Health Risk Factor

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Surface temperatures on a hot clear summer day are higher than most people realize and pose a significant danger to health. Weather forecasts provide the expected high temperature for the day, humidity, air pollution level, and UV-index, but do not warn the public about the risks from potential high surface temperatures on a clear hot summer day. A study commissioned by the Riverside Optimist Club in Windsor, in collaboration with the Public Health Units of Windsor-Essex, Sarnia-Lambton and Chatham-Kent in southwestern Ontario using LANDSAT-7 satellite imagery to measure the surface temperatures of over 800 schoolyards and public spaces found average surface temperatures ranging from 9 to 103 degrees Celsius when air temperature was just over 25 degrees Celsius. These extreme temperatures decrease physical activity levels, indicate high levels of UV radiation, and have negative health consequences for people in general and vulnerable populations in particular. While warnings are given to restrict activities, the public is often not told where, when, or why. Better knowledge by the public of the existence of and risks to them of superhot surfaces would enable the public to make better choices for their travels and activities in hot weather. This information would prevent unnecessary and unhealthy decreases and restrictions of physical activity and increases of social isolation.

POSTER - Planetary and Exo-Planetary Atmospheres, Surface Interactions / AFFICHE - Atmosphères planétaire et exoplanétaires, interactions de surface et exobiologie

Room / Endroit (Soprano), Chair / Président (John C. McConnell), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D411.1 ID:5715 15:30

Rethinking radar product generation: towards a better use of the time dimension in near-real time products

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In real-time applications, the immediate correction of erroneous radar data (due to clutter, attenuation, etc.) is often done without taking into account the valuable information provided by past or near-future scans. Small storm cells, for instance, can be entirely obscured by areas of ground clutter: looking at a single radar scan at 1700Z will not allow us to detect the obscured storm's intensity or position. If we then examine reflectivity data from times 1705Z and 1655Z, however, we discover a new pool of information about the storm's structure and evolution. Likewise, radar rainfall accumulation products could be improved by incorporating information from different times, rather than by simply interpolating in space over the missing information, or by ignoring regions of "bad" pixels altogether. In this work, we evaluate how past and future radar scans can be used to improve the cleaning of radar data (e.g., clutter suppression, attenuation correction, etc.) as well as the computation of hydrological products such as rainfall accumulation (e.g., improved estimate of bright band height). Variograms are built to explore the autocorrelation structure of radar reflectivity in time and space. Finally, we create an algorithm to determine, in near-real time, how we can best combine information from different times and locations in order to "fill" cluttered gaps in the reflectivity data.

POSTER - Biomass Burning Smoke Plumes: Atmospheric Impacts, Detection, and Prediction/ AFFICHE -Panaches de fumée issue de la combustion de la biomasse: impacts sur l'atmosphère, détection et prévision

Room / Endroit (Soprano), Chair / Président (David Waugh), Date (31/05/2012), Time / Heure (15:30 - 16:30)

POSTER - Operational ice-ocean analysis and prediction / AFFICHE - Analyse et prévision opérationnelles glace-océan

Room / Endroit (Soprano), Chair / Président (Mark Buehner), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D405.1 ID:5524 15:30

SEASONAL CIRCULATION IN THE CANADIAN ARCTIC ARCHIPELAGO

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The Canadian Arctic Archipelago (CAA) is a complex network of straits and basins connecting the Arctic Ocean and the Atlantic Ocean. The aim of our study is to understand the variability in volume transport passing through the CAA. A configuration of the Nucleus for European Modeling of the Ocean (NEMO) ocean/sea ice model is set up to study the seasonal and inter-annual circulation for the Canadian Arctic Archipelago. The seasonal circulation pattern in the Canadian Arctic is well simulated. In general, the modeled volume transport through western Lancaster Sound agrees well with observations. We use model sensitivity experiment to demonstrate that from January to May the ice stress on the ocean reduces the volume transport through Parry Channel.

POSTER - Ocean-atmosphere modelling and analysis / AFFICHE -Modélisation et analyse océan-atmosphère

Room / Endroit (Soprano), Chair / Président (Youyu Lu), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D406.1 ID:5339 15:30

Climatic impacts of stochastic fluctuations in air-sea fluxes

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Air-sea fluxes vary on scales that are too small and fast to be resolved explicitly by coupled atmosphere-ocean general circulation models. This presentation proposes a nonlinear physical mechanism by which stochastic fluctuations in the air-sea buoyancy flux may modify the mean climate. The paper then demonstrates the mechanism in climate simulations with a comprehensive coupled general circulation model. Significant changes are detected in the time-mean oceanic mixed-layer depth, sea-surface temperature, atmospheric Hadley circulation, and net upward water flux at the sea surface. Also, El Nino Southern Oscillation (ENSO) variability is significantly increased. The findings demonstrate that noise-induced drift and noise-enhanced variability, which are familiar concepts from simple climate models, continue to apply in comprehensive climate models with millions of degrees of freedom. The findings also suggest that the lack of representation of sub-grid variability in air-sea fluxes may contribute to some of the biases exhibited by contemporary climate models.

3D406.2 ID:5682 15:30

Contribution of Tibetan Plateau snow cover to the extreme winter condition of 2009-2010

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Most of the Northern Hemisphere experienced an extreme climate condition during the 2009-2010 winter. This winter in Canada was characterized by the warmest and driest in the past 60 years. Across much of the U.S., Europe and northern Asia, persistent below normal temperature caused a significant adverse economical and societal impact. Dynamical seasonal forecasting systems failed to predict this winter's extreme condition. Here we show that the snow cover anomaly over the Tibetan Plateau and the adjacent area is significantly correlated with the atmospheric circulation pattern that contributes to this anomalous winter condition. A statistical model using this snow cover information and the El Nino signal in autumn 2009 was able to predict the general distribution of the anomalous condition of this winter. This implies that an improved understanding of the Tibetan Plateau snow cover effect and its representation in general circulation models are important for seasonal predictions, of high-impact climate events in particular

POSTER - Ocean Observation Systems / AFFICHE -Systèmes d'observation des océans

Room / Endroit (Soprano), Chair / Président (Michael Ott), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D407.1 ID:5482 15:30

Status of marine automatic voluntary observing ships (AVOS) and moored buoy networks

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Environment Canada presently operates 51 Automatic Voluntary Observing Ships (AVOS) and a network of 47 moored weather buoys across Canada. The AVOS system was first deployed in late 1990’s as replacement to manual VOS fleet. It initially uses INMARSAT for data transmission. Because data collection rate is low in the high northern latitudes and Arctic when INMARSAT is used, as of 2009, the MSC has been implementing IRIDIUM telemetry in the operational AVOS. The IRIDIUM telemetry system is able to transmit data when ships are at the Arctic region. At present, 47 ships retrofitted from INMARSAT to IRIDIUM telemetry, and AVOS observations increased from 65K in 2008 to 240K in 2011. Data quality control (QC) is done at the computer system on the ship, and the FM13 formatted data is disseminated on global transmission system (GTS), as well as available from a password protected website.

Since the first buoy deployment in 1986, the Canadian buoy program has expanded to become one of the largest buoy programs in the world. Marine tragedies in early 1980‘s on the Pacific and Atlantic coasts provided significant impetus for the improvement of marine weather services. To address this need, over 47 automated buoy stations now provide over 300,000 hourly observations annually in the Pacific Ocean, Atlantic Oceans, as well as the Great Lakes and other Interior Lakes. All moored buoys use GOES satellite as a channel for data transmission. GOES Data Collection System requires user to move up from 100 bps to higher baud rate data transmission, and the purpose is to free up high data rate channels. At present, about 50% of moored buoys have upgraded to transmit in 300 bps using SUTRON SatLink 2 Transmitters. The goal will be to upgrade all moored buoys to transmit in 300 bps by 2013.

3D407.2 ID:5559 15:30

Can light attenuation estimates from electronic seal tags be used as phytoplankton proxies on the Scotian Shelf?

Karl Bryan Lagman [1], *Katja Fennel* [1], *Laura Bianucci* [1], *Don Bowen* [2], *John Cullen* [1], *Richard Davies* [1], *Damian Lidgard* [1], *Sara Iverson* [1]
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We aim to test whether light measurements from electronic tags deployed on grey seals can be used to monitor spatial and temporal changes in phytoplankton biomass on the Scotian Shelf. Phytoplankton is a major contributor to vertical light attenuation, thus it may be possible to infer changes in phytoplankton biomass from changes in the light attenuation coefficient determined from seal tags. Between September and December of 2009 and 2010, 33 electronic tags were deployed on grey seals that measured pressure, temperature and light every 10 s. Individual grey seals performed 200-300 dives to the sea floor resulting in a similar number of light attenuation profiles. Pre-processing of light data obtained between local 10:00 h and 14:00 h revealed systematic differences in measured irradiance between the ascent and descent phase of the dives due to changes in the orientation of the light sensor, which was not designed for quantitative estimation of irradiance. Attenuation coefficients in the mixed layer were estimated from irradiance profiles obtained during the ascent phase. Measurements from the light sensors were intercalibrated and validated by deploying the tags on a sampling device with a full suite of bio-optical measurements and coincident with bottle sampling. These observations were also used to establish a proxy relationship between attenuation coefficients and phytoplankton biomass.

3D407.3 ID:5489 15:30

Characterization of the Nova Scotia current and water properties along the Halifax Line: an observational integrated approach.

Mathieu Dever [1], *Blair Greenan* [2], *Peter Smith* [2], *David Hebert* [2], *Jinyu Sheng* [1]

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Since 2008, operations to deploy an “acoustic curtain” of hydrophone receivers along the Halifax Line on the Scotian Shelf have been carried out as part of the Ocean Tracking Network research project. Preliminary results of acoustic tag detections by the hydrophones suggested that marine species cross the Halifax Line away from the Nova Scotian Current maximum (located roughly between the 100 m and 200 m isobaths) and at times when the Nova Scotia Current is at its weakest. The aim of this study was to develop an observational, integrated approach toward characterizing the Nova Scotia Current using a wide range of observations, in order to link migration routes to local oceanic circulation. Acoustic Doppler Current profilers coupled with newly-acquired ocean gliders were used to provide a high-resolution visualization of the Nova Scotia Current and its variability, both spatially and temporally. In addition, hydrographic properties (T, S and O_2) from moored near- bottom Microcat, CTD transects from the gliders and ongoing vessel-based AZMP program are being used to investigate and quantify the impact of different sources of forcing (e.g. tides, the atmosphere and freshwater input) on the local oceanic circulation. An accurate description of the relationship between migration patterns and oceanic circulation will contribute significantly to the adequate management of local marine resources, while observational data collected during this project will be useful to develop and validate ecosystem models.

POSTER - Acoustics in Oceanography / AFFICHE - Acoustique et océanographie

Room / Endroit (Soprano), Chair / Président (Tetjana Ross), Date (31/05/2012), Time / Heure

(15:30 - 16:30)

3D7.1 ID:5773 15:30

Acoustic detection of sediment-laden ice blocks

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Sediment-laden ice, unique to cold tidal regions, may pose a risk to tidal power development in the Minas Passage. Managing this risk requires an understanding of the processes that permit the formation and release of ice blocks in tidal regions, as well as the ability to predict life cycle and mobility. Acoustic observations of sediment-laden ice may allow for mitigation as well as providing information about the ice blocks, where changes in acoustic impedance contribute to backscattering of the acoustic signal. Since literature characterizing sediment-laden ice is relatively sparse, it is difficult to predict the acoustic return. Ice blocks collected from Kennetcook River and Debert Beach will be used to characterize the composition, layering and inclusions of air or brine pockets. This information combined with preliminary scattering experiments using manufactured ice will drive models allowing the interpretation of acoustic in terms of ice properties.

3D7.2 ID:5813 15:30

Differentiating biological and physical forcing in patterns of acoustic backscatter

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The oceanographic world is full of acoustic backscatter imagery that has never been analyzed as imagery. This work applies wavelet-based techniques developed to characterize the transition to turbulence in non-oceanographic applications. By analyzing the local scaling relationship of every data point to its neighbors, these techniques easily distinguish regions that are structured primary by either 2-D or 3-D turbulence from one another. In addition, it is sometimes possible to distinguish regions structured primarily by distinct zooplankton communities, although this is a much harder problem. The implications of patterns in acoustic backscatter data are not always fully explored. These techniques aim to extract the quantitative statistical information locked in the spatial structure of large acoustic backscatter datasets that might otherwise be relegated to qualitative background information.

3D7.3 ID:5837 15:30

Using Micro-Bubbles as Acoustic Targets for Large Scale Fluid Flow Experiments

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There are many times when it is useful to operate or test acoustic profiling and velocity sensors in laboratory facilities. Unfortunately, the often clean, clear water in such facilities provides little or no backscatter for these instruments to operate. Additional scatterers may be introduced in some cases but this can be unpractical in large facilities or may introduce volumes of particulate matter that are unacceptable. In this paper, the use of the Dissolved Air Floatation (DAF) method for creating large quantities of microscopic bubbles to serve as acoustic targets is described. The advantage of the approach is that it is comparatively inexpensive and does not contaminate the water in any way. A limitation of the approach is that bubbles rise through the water and therefore must be continuously produced. The method is demonstrated in the

Institute of Ocean Technology – Ice Tank facility which is 12 m wide, 3 m deep, and 90 m long. In this tank, a large plume of bubbles could be injected at mid-depth and would collectively rise to the surface at a speed of 5 to 10 cm/s. The rise speed for individual 100 μm bubbles generated with a DAF system is about 1 cm/s so it is likely that bubble residence time could be increased by dispersing the bubbles throughout the water column and thereby avoiding a bouyancy plume.

POSTER - Climate Change and the Carbon Cycle / AFFICHE - Changements climatiques et le cycle du carbone

Room / Endroit (Soprano), Chair / Président (Kirsten Zickfeld), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D408.1 ID:5632 15:30

The effect of driving climate data on the simulated terrestrial carbon pools and fluxes

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Regional climate change strongly impacts local surface vegetation characteristics, which in turn affect the regional climate through vegetation feedbacks. The dynamic vegetation model, the Canadian Terrestrial Ecosystem Model (CTEM), has been coupled to the Canadian Land Surface Scheme (CLASS3.5), which is the land-surface scheme in the Canadian Regional Climate Model (CRCM5). CTEM can grow vegetation from bare ground and includes processes of photosynthesis, autotrophic and heterotrophic respiration, phenology, turnover, mortality and allocation. This presentation will focus on the effect of the driving climate data on the simulated terrestrial biosphere including the simulated vegetation biomass and leaf area index. We compare CTEM simulated vegetation quantities over the recent past (1958-1999) when driven with ERA40 and NCEP reanalysis data over North America with observation-based data. CLASS/CTEM appear to overestimate the woody biomass and the gross and net primary productivities, especially when driven with the NCEP data, but tend to underestimate the LAI depending on the driving data used. Rising atmospheric CO2 concentrations and temperatures over the 1970-1999 period lead to an increase in vegetation biomass, the gross and net primary productivities and the soil carbon mass.

3D408.2 ID:5676 15:30

Proposal for a new metric to compare the climate effects of emissions of non-carbon dioxide greenhouse gases

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The need of the international community to set and meet targets for greenhouse gas emissions reductions,

requires a means of comparing the climate response to emissions of different types of greenhouse gases. Quantifying and comparing the climate response to emissions of gases such as methane and nitrous oxide is challenging due to differences in the radiative forcing that results from a given emission, as well as the differing atmospheric lifetimes of different gases. Currently, the Global Warming Potential (GWP) is the most widely used greenhouse gas metric, which represents the average change in radiative forcing over 100 years following a given emission. GWP has been criticized widely, however, on account of its inability to capture the nuances of short- vs. long-term climate responses, as well as its use of radiative forcing rather than some more direct measure of climate change. In this paper, we propose a new metric for quantifying and comparing the climate response to emissions of non-carbon dioxide greenhouse gases. This metric is defined as the global temperature response to cumulative emissions of non-CO2 gases, compared to the response to emissions of CO2. We present a calculation of the metric using simulations of the climate response to historical increases in atmospheric concentrations of non-CO2 greenhouse gases, using an intermediate-complexity climate model. Model runs were driven by low and high estimates of radiative forcing since the pre-industrial era to assess the contributions of this uncertainty to the overall metric calculation. In addition, we consider the uncertainty associated with historical estimates of methane and nitrous oxide emissions as a contributor to uncertainty in the simulated climate response to these emissions. This proposed greenhouse gas metric represents alternate method to compare the climate response per unit emission of different greenhouse gases, based on historical data and model simulations, and may be a useful policy tool to inform international greenhouse gas emissions trading.

POSTER - Atmosphere, Ocean and Climate Dynamics / AFFICHE -Dynamique de l'atmosphère, des océans et du climat

Room / Endroit (Soprano), Chair / Président (Ronald J. McTaggart-Cowan), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D409.1 ID:5411 15:30

Upper-Level Precursors Associated with Subtropical Cyclone Formation in the North Atlantic Basin

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Oceanic cyclones exhibiting properties of both tropical and extratropical systems have been categorized as “subtropical” since the early 1950’s. The development of these subtropical cyclones (STCs), sometimes called hybrid cyclones in the current literature, requires the existence of a baroclinically unstable environment, quasigeostrophic forcing for ascent, and the production of lower-to-midtropospheric potential vorticity (PV) from diabatic heating. Previous studies have established that STCs are associated with negligible surface baroclinicity and significant lower-to-midtropospheric PV during their formation. The hybrid nature of STCs makes them ideal candidates to become tropical cyclones (TCs) via the tropical transition process.

The opportunity to enumerate the relationship between STCs, TC activity, and high-impact weather events motivates this presentation. We will analyze the structure, motion, and evolution of the upper-level precursors linked to STC formation in the North Atlantic Basin. Emphasis will be placed on documenting precursor synoptic-scale anticyclonic wave breaking (AWB) events associated with midlatitude intrusions of cold air into the subtropics. Elongated PV streamers that develop equatorward of precursor AWB events enable relatively cold air in the upper troposphere to reach the subtropics. These PV streamers and the associated cold air can help to destabilize the subtropical troposphere and permit the development of the deep convection that can serve as a catalyst for STC development.

The current study will present a climatology of North Atlantic STCs from a dynamical perspective. Intraseasonal and interannual variability in STC frequency will be documented, and a composite analysis of the upper-level features associated with STC development will be presented. Emphasis will be placed on identifying the origins of the upstream precursors responsible for AWB events in the midlatitudes and of the corresponding intrusions of relatively cold upper-tropospheric air into the subtropics.

3D409.2 ID:5613 15:30

Invigoration of cumulus cloud fields by mesoscale ascent

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Although the basic role of mesoscale ascent (from mountains, gravity waves, sea breezes, etc.) on the initiation of atmospheric convection is well established, little attention has been devoted to the detailed internal response of clouds subject to this forcing. In this study, large-eddy simulations of precipitating trade-wind cumuli impinging on an idealized island ridge are conducted to investigate the role of forced ascent on the morphology, internal dynamics, and microphysics of a resolved cumulus field. Despite being trapped beneath a sinking trade-wind inversion, the simulated island clouds are more numerous, vigorous, and liquid-rich than those over the upstream ocean. This invigoration results in part from a sharp increase in horizontal cloud size over the island, which reduces the dilution of buoyant convective cores by the entrainment of environmental air. The increased coverage and precipitation efficiency of the island clouds increases the mean precipitation rate 20-fold compared to that over the upstream ocean. The island cloud broadening is favoured by the presence of broad water-vapour anomalies within the impinging airstream that are forcibly lifted to saturation, along with basic energetic constraints that support wider, less dilute clouds in areas of rapid ascent. Radar and in situ aircraft observations over the mountainous Caribbean island of Dominica are presented to evaluate the conclusions drawn from large-eddy simulation.

3D409.3 ID:5517 15:30

An Overview of Central American Gyres

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Monsoon gyres, commonly found over the western Pacific Ocean, are characterized by broad low-level cyclonic circulations that occur at a variety of spatial scales ranging from 1500-3000 km. Low-level cyclonic gyre circulations, while less frequent, have also been observed over Central America during the latter half of the tropical cyclone (TC) season. A noteworthy gyre observed during the 2010 PREDICT field project served as a “collector” of TC Matthew and a source for TC Nicole. During October 2011, devastating

flooding occurred in Guatemala and El Salvador when TD 12-E, embedded in a gyre circulation, made landfall on the Pacific coast of Central America. These gyre occurrences, their apparent links to TC activity, and their association with high-impact weather motivates this presentation. A preliminary analysis of Central American gyres suggests that their spatial scales vary between 1000-2000 km. These gyres also tend to be co-located with reservoirs of deep moisture that are characterized by high precipitable water values (>50 mm) and embedded deep convection on their southern and eastern sides. Catastrophic flooding can occur when the gyre circulation, containing this deep reservoir of tropical moisture and convection, interacts with the high and rugged terrain of Central America. A Central American gyre climatology to include gyre frequency, duration, and intensity will be presented. An evaluation of how TC genesis occurs in gyre environments will also be presented. Emphasis will be placed on documenting and understanding gyre formation and evolution, including the role of mid- latitude features in the process. The impact of Central American topography in enhancing cyclonic vorticity within a gyre will also be discussed. Gyre development and evolution will also be analyzed within the context of synoptic, intraseasonal, and interannual circulations in the tropics to include convectively coupled Kelvin waves, the Madden-Julian Oscillation, and the El Nino-Southern Oscillation (ENSO).

3D409.4 ID:5340 15:30

The role of mean ocean salinity in climate

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We describe numerical simulations designed to elucidate the role of mean ocean salinity in climate. Using a coupled atmosphere-ocean general circulation model, we study a 100-year sensitivity experiment in which the global-mean salinity is approximately doubled from its present observed value, by adding 35 psu everywhere in the ocean. The salinity increase produces a rapid global-mean sea-surface warming within a few years, caused by reduced vertical mixing associated with changes in cabbeling. The warming is followed by a gradual global-mean sea-surface cooling within a few decades, caused by an increase in the vertical (downward) component of the isopycnal diffusive heat flux.

We find no evidence of impacts on the variability of the thermohaline circulation (THC) or El Niño/Southern Oscillation (ENSO). The mean strength of the Atlantic meridional overturning is reduced and the North Atlantic Deep Water penetrates less deeply. Nevertheless, our results dispute claims that higher salinities for the world ocean have profound consequences for the thermohaline circulation.

In additional experiments with doubled atmospheric carbon dioxide, we find that the amplitude and spatial pattern of the global warming signal are modified in the hypersaline ocean. In particular, the equilibrated global-mean sea-surface temperature increase caused by doubling carbon dioxide is reduced. We infer the existence of a non-linear interaction between the climate responses to modified carbon dioxide and modified salinity.

3D409.5 ID:5904 15:30

An Unstructured Grid Higher Order Discontinuous Galerkin Global Model of Global Ocean Tides

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The emergence of models with higher resolutions near the coastlines and courser mesh offshore, has been evolved due to the significant impacts of coastline configuration and bathymetry (associated with sea level rise) on the amplitude and phase of tidal constituent not only in the present conditions but also in the deep past [Griffiths and Peltier 2008, Griffiths and Peltier 2009, Hill et al 2011]. A global tidal model with enhanced resolution at the poles has been developed by Griffiths and Peltier [2008, 2009], which, although capable of highly resolving polar ocean tides , is based upon a standard structured Arakawa C grid and hence is not capable of resolving coastlines. Furthermore, the use of a nested modelling approach, although it may enable local spatial refinement [Hill et al 2011] it nonetheless suffers from its inherent dependence on the availability of a global tidal model with necessarily low spatial resolution to provide the open boundary conditions. On the other hand, an unstructured triangulation of the global domain provides a standalone framework to study highly resolved regions without relying on secondary models. The first step in the development of the structure we are employing was described in Stuhne and Peltier [Ocean Modeling, 2006]. In further extending this modelling structure we are employing a new discontinuous Galerkin discretization of the governing equations in order to provide a very high orders of accuracy while ensuring that momentum transport is locally conserved [Giraldo et al. 2002].

In this initial stage of development of the model, the governing shallow water equations are extended to include the influence of internal tide drag in the deep ocean as well as the drag in shallow marginal seas together with the influence of gravitational self-attraction and loading. In this paper, we will explain the mathematical and numerical framework employed in the development of the global tidal model and present the validation results obtained using the present-day satellite altimetry data-constrained TPXO 6.2 global tidal solutions of Egbert et al. [1994].

Time permitting, we will also employ the model to assess the variation of different tidal constituents during the Last Glacial Maximum (LGM) by reconstructing the paleotopography using the ICE-5G model of Peltier [2004]. These analyses are being performed so as to selectively focus upon different regions of interest, for example the Arctic Ocean and the southern hemisphere western Atlantic in the vicinity of the Patagonian shelf.

POSTER - Renewable Energy – The Important Role of Atmospheric Science / AFFICHE -Énergie renouvelable : l'importance des sciences de l'atmosphère

Room / Endroit (Soprano), Chair / Président (Joël Bédard), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D410.1 ID:6174 15:30

Detection of rapid wind changes using image processing techniques applied to surface pressure fields

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Currently, wind energy is one of the fastest-growing forms of renewable energy, both in Canada and around the world. A significant operational obstacle for wind energy production is the “wind ramp”. When the wind changes rapidly, causing a sudden increase or decrease in the wind power generated by turbines, energy system operators must quickly take steps to integrate or remove power from the transmission system. Consequently, wind ramp forecasting is a hot topic for short-term wind energy forecasting. Wind ramps may be associated with fronts, thunderstorms outflows, and topographically induced flows. We focus here on fronts, which are typically characterized by sharp temperature changes, a pressure trough and abrupt wind changes.

Since fronts are mainly associated with strong temperature gradients, much of the previous work on front detection has been based on an analysis of temperature fields. However, wind shifts are more frequently associated with pressure troughs than with temperature changes. Consequently, the detection of pressure troughs can add value to wind ramp forecasting, especially when attempting to detect or forecast the wind changes accompanying fronts. Since troughs are elongated regions of relatively low pressure, it is possible to devise computational methods to identify them automatically in the surface pressure field. The technique described in this paper identifies trough lines by connecting points of maximum curvature in the pressure field. It is based on techniques used for image processing. We illustrate how it works by using pressure fields extracted from the North American Regional Reanalysis (NARR) dataset. A case study shows how an identified pressure trough relates to changes in wind power production in southern Alberta. In the future, this technique could also be applied to forecast surface pressure fields, in order to forecast wind ramp events associated with frontal pressure troughs.

3D410.2 ID:5384 15:30

SEASONAL VARIABILITY OF TOTAL SUSPENDED MATTER IN MINAS BASIN, THE BAY OF FUNDY

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Minas Basin, at the eastern end of the Bay of Fundy in Nova Scotia, Canada, is a large macro-tidal estuary. Strong currents associated with the very large tidal water level range could potentially provide a source of renewable tidal energy, but are a fundamental part of the Bay of Fundy ecosystem. Significant extraction of tidal energy could lead to local and far field changes in the tidal regime and sediment dynamics. We present observations of total suspended matter (TSM) concentrations from ocean colour imagery (MERIS data) in Minas Basin from May 2008 to July 2011. Time series of TSM in 1-km-square pixel boxes throughout the Basin were produced, and temporal autocorrelation analysis has been carried out with those time series. The analysis shows a strong semi-annual variability in TSM concentration in most parts of the Basin. Larger TSM is observed in mid-winter (Feb-Mar), and smaller TSM characterizes mid-summer (Jul-Aug). The strength of this signal varies throughout the Basin, with the largest variation occurring in the centre of Minas Basin, and the smallest variation occurring in Cobequid Bay. It is notable that the variation is smaller in Cobequid Bay but the TSM is the highest in this region. The maximum and mean TSM derived from both summer and winter MERIS data were compared to predictions using the Delft3D model, using different

values of the critical bed shear stress for muds to approximate different biologically-controlled sediment cohesion in the different seasons. Comparison between the magnitude and spatial patterns of observed and simulated TSM will help to evaluate the appropriate sediment parameters in the model and understand the observed seasonal variability of sediments in suspension.

3D410.3 ID:5786 15:30

CLIMATOLOGIE DE L'ENSOLEILLEMENT AU QUÉBEC

Dominic Matte [1], *Richard Leduc* [2], *Nathalie Barrette* [2]

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L'étude vise à faire une climatologie de l'ensoleillement au Québec. Pour ce faire, des données d'ensoleillement direct cumulées, dans le cadre du programme de surveillance du climat du ministère du Développement durable, de l'Environnement et des Parcs (MDDEP), ont été validées. Une mise à jour de la méthodologie fut élaborée pour une nouvelle climatologie de l'ensoleillement. Suite à la validation de la banque de données, différentes corrections ont été effectuées afin de pouvoir en faire une utilisation adéquate pour le projet. Une modélisation de la radiation, avec le modèle d'Angström, fut réalisée. Cette modélisation a permis de cartographier, en autre, la radiation au Québec méridional. Une fois la radiation calculée, cette dernière fut vérifiée à l'aide de mesures directes de la radiation ce qui a donné un coefficient de corrélation supérieur à 98%. Les analyses des différentes cartes créées lors de cette étude permettent une distinction à plusieurs niveaux de la climatologie de l'ensoleillement. Les structures d'ensoleillement évoluent de façon différente durant l'année. Lors des périodes hivernales, une structure principalement parallèle à l'axe du fleuve St-Laurent prédomine. Tandis que pour les autres mois (mai à août), une structure de l'ensoleillement plutôt latitudinal prédomine. De plus, on remarque que durant la période hivernale, il y a une plus grande complexité dans les structures d'ensoleillement que dans la période estivale.

3D410.4 ID:5848 15:30

Wind turbine noise propagation modelling

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A sound propagation model based on ray theory has been applied to calculate the trajectories of sound rays emitted from a wind turbine in three dimensions. This model will calculate the sound pressure level surrounding a wind turbine. According to the Ontario Ministry of Environment (MOE) guideline, the sound pressure level at the receptor cannot exceed 40 dBA. In the model the rotor center of the wind turbine is considered as a point source and the sound propagating from the turbine is considered as a combination of rays spreading in all directions. The ray velocity is the vector sum of local medium speed and the sound speed in the direction of ray propagation. The ray tracing equations were numerically solved to calculate the trajectories until they reach the ground. During propagation, sound waves are subject to different types of losses. Algorithms to calculate losses due to spherical spreading, refraction and atmospheric absorption have been developed and are being integrated into the mathematical model. Reflection from the ground will also be treated and the loss due to this ground interaction will be calculated using the impedance of the local ground surface. The nature of terrain variations can also have significant effect on the wind profile and hence influence the sound propagation and noise levels at receptor locations.

POSTER - Regional Climate Modelling and Climate Projections PART 2 / AFFICHE -Modélisation du climat régional et projections du climat PARTIE 2

Room / Endroit (Soprano), Chair / Président (Laxmi Sushama), Date (31/05/2012), Time / Heure (15:30 - 16:30)

3D8.1 ID:5618 15:30

CRCM5 simulations over CORDEX-West Asia domain: Evaluation of Indian Summer Monsoon

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The Indian summer monsoon (ISM) is the major source of rainfall for a large percentage (more than 60%) of the world total population living in India, Bangladesh, Myanmar and Nepal; it is therefore desirable to predict the onset, withdrawal of ISM and its precipitation accurately. The performance of the fifth generation of the Canadian Regional Climate Model (CRCM5) in simulating of ISM circulation and its onset and withdrawal and associated precipitation is meticulously evaluated in a consistent framework over 30-year (1971-2000) time period. During the monsoon period, the CRCM5 is able to capture the spatial pattern of precipitation for south-central India and coast of Myanmar while CRCM5 underestimates the precipitation, especially in the central and northeastern part of India and Himalayas. The model is too warm in northern India in comparison to reanalysis and CRU TS 3.1 data. The model has successfully captured the patterns as well as the strength of the winds at different pressure levels with slight overestimation of lower level wind in the Arabian Sea and the Bay of Bengal and upper level westerly in northern India. CRCM5 well reproduces the planetary-scale variations associated with the Indian summer monsoon while it has some difficulties to reproduce the strength of the monsoon. The timing of the monsoon onset of the CRCM5 is in good agreement with observed data over central and southern part of India (peninsular) whereas over the east cost of India, the onset is somewhat delayed. CRCM5 has difficulties in reproducing observed monsoon withdrawals. Simulated monsoon period is nearly 7 pentads longer than that of reanalysis.

3D8.2 ID:5313 15:30

Climate-change projections made with the fifth-generation Canadian Regional Climate Model (CRCM5) over the African CORDEX domain

Kossivi Yewougni Tete , *Leticia Hernandez-Diaz* , *Rene Laprise* , *Laxmi Sushama* , *Andrey Martynov* , *Katja Winger* , *Michel Valin*

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This poster presents climate-change projection results obtained over Africa with the new fifth-generation

Canadian Regional Climate Model (CRCM5), following the CORDEX (COordinated Regional climate Downscaling EXperiment) experimental protocol. CRCM5 is driven by the CanESM2 global model for the period 1950-2100 for the RCP4.5 emission scenario. We evaluate CRCM5 performance to reproduce current climate and also discuss the climate changes projected for Africa.

3D8.3 ID:5329 15:30

Validation of the fifth-generation Canadian Regional Climate Model (CRCM5) over the African CORDEX domain

Kossivi Yewougni Tete [1], *Leticia Hernandez-Diaz* [1], *Rene Laprise* [1], *Laxmi Sushama* [1], *Andrey Martynov* [1], *Katja Winger* [1], *Bernard Dugas* [2], *Michel Valin* [1]

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Africa has been affected in recent years by climatic extremes and a major challenge for people is to adapt to these extreme weather events. This poster presents several maps in an effort to assess the skill of the new fifth-generation Canadian Regional Climate Model (CRCM5) to reproduce the observed climate in Africa. CRCM5 is driven by ERAInterim reanalyses for the period 1984-2008, following the CORDEX (COordinated Regional climate Downscaling EXperiment) protocol. This experiment provides an opportunity to test the model outside its native region, as recommended by the World Climate Research Programme. Overall the model succeeds in reproducing the main features of the geographical distribution and seasonal cycle of temperature and precipitation over Africa.

3D8.4 ID:5586 15:30

Climate-change projections with the fifth-generation Canadian Regional Climate Model (CRCM5) over the North American CORDEX domain

Adelina Alexandru [1], *Leo Separovic* [2], *René Laprise* [2], *Andrey Martynov* [2], *Laxmi Sushama* [2], *Katja Winger* [2], *Michel Valin* [2]

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This presentation will summarise our contribution to CORDEX (COordinated Regional climate Downscaling Experiment) by providing an overview of high-resolution simulations performed with the 5th generation of the Canadian RCM (CRCM5) over a CORDEX domain covering North America. All CRCM5 simulations, driven by different AOGCM models, members of the CMIP5 multi-model ensemble, span the period 1951-2100 including the transient climate change during 150 years. In particular, we will evaluate CRCM5 performance by comparing the historical part of GCM driven simulations to observations and CRCM5 simulations driven by reanalyses. We will also discuss how the CRCM5 performance and future climate projections over North America are affected by the choice of driving AOGCM simulations.

3D8.5 ID:5337 15:30

Precipitation characteristics over Africa as simulated by the Canadian RCM

Bessam Bouagila

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Validation of the fifth generation of the Canadian RCM (CRCM5) simulated dry/wet spell characteristics over

Africa, including mean number of dry/wet spells and selected return levels (5 and 10 years) of extreme dry/wet spell durations, are presented. Validation is performed by comparing ERA-interim driven CRCM5 simulated characteristics with those derived from the Global Precipitation Climatology Project (GPCP) dataset, for the common 1997-2008 period. The return levels of extreme dry/wet spell durations are computed by performing frequency analysis of peaks-over-threshold (POT) series; the POT-based analysis is more suitable compared to the one based on the annual/seasonal maximum approach, particularly for short samples, as it utilizes more data compared to the annual/seasonal maximum approach. Projected changes to the dry /wet spell characteristics are also analysed using the current (1980–201) and future (2041–2070 and 2070-2100) CRCM5 simulation driven by the Canadian Earth System Model (CanESM2) for the RCP4.5 scenario.

3D8.6 ID:5765 15:30

Canadian Regional Climate Model, version 5: performance in simulating the current climate over North America

Andrey Martynov , *René Laprise* , *Laxmi Sushama* , *Katja Winger* , *Bernard Dugas*
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The Canadian Regional Climate Model, version 5 (CRCM5) has been used for simulating the current climate of North America (1989-2008). The model-simulated climate for different sub-regions, including NARCCAP domains, North American Monsoon zone and the zone of the Great Plains Low Level Jet is presented and compared with observation data on air temperature and precipitation. The ability of the model to reproduce the essential elements of the climate of the North American continent is assessed. The performance of the interactively-coupled 1D lake model FLake in coupled simulations is also evaluated in comparison with observations, where available.

Operational ice-ocean analysis and prediction PART 1 / Analyse et prévision opérationnelles glace-océan PARTIE 1

Room / Endroit (Symphonie 1), Chair / Président (Thomas Carrieres), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E3.1 ID:5689 INVITED/INVITÉ 16:30

Evaluation of the CONCEPTS Global Ice-Ocean Prediction System

Gregory Smith [1], *Francois Roy* [1], *Matt Reszka* [1], *Zhongjie He* [1], *Mark Buehner* [1], *Christiane Beaudoin* [1], *Frederic Dupont* [1], *Jean-Francois Lemieux* [1], *Fraser Davidson* [2], *Hal Ritchie* [1], *Youyu Lu* [2], *Charles-Emmanuel Testut* [3]
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We present results from the ¼ degree resolution global ice-ocean prediction system being developed as part of CONCEPTS (Canadian Operational Network of Coupled Environmental PredicTion Systems), in collaboration with the French operational ocean forecasting centre Mercator-Océan. This system has been running routinely at the Canadian Meteorological Centre since December 2010 producing weekly analyses and 10 day ice-ocean forecasts using the NEMO modeling system and the Mercator assimilation system. The Mercator data assimilation system is a multi-variate reduced-order extended Kalman filter that assimilates sea level anomaly, sea surface temperature (SST) and in situ temperature and salinity data. Ice fields are initialized using Canadian Meteorological Centre (CMC) daily ice analyses. Here, we present an evaluation of the global prediction system with a focus on the forecast skill of SST and sea ice concentration. An evaluation of SST forecasts using AVHRR satellite observations and the CMC SST analyses demonstrates a significant improvement over persistence and anomaly persistence in many regions. Results point to the marginal ice zone (MIZ) as the most difficult region to constrain adequately. Despite SST errors in the MIZ, verification of ice forecast skill against NOAA IMS analyses shows that the system provides a clear improvement as compared to persistence and is able to capture a number of rapid freeze-up events. However, the system demonstrates a tendency to overestimate ice cover due to excessive ice formation and a lack of landfast ice. Finally, current and future developments to improve the forecasting system are discussed.

3E3.2 ID:5510 17:00

Overview of an integrated marine Arctic prediction system for METAREAs

Harold Ritchie [1], *Mark Buehner* [2], *Tom Carrieres* [3], *Serge Desjardins* [4], *Luc Fillion* [2], *Edwina Lopes* [5], *Pierre Pellerin* [2], *Gregory Smith* [2], *Gilles Garric* [6]

(Presented by *C. Harold Ritchie*)

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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, thickness, pressure, drift, ice edge), freezing spray, waves and ocean conditions (temperature and currents). The core of the system is 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) ocean model and the CICE ice 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, discuss plans for future operational systems, and link with other complementary presentations at this Congress.

3E3.3 ID:5761 17:15

Enhancing the Canadian METAREAS operational coupled ocean-ice-atmosphere analysis and forecasting system for fine-scale applications in the Beaufort Sea

Fraser Davidson [1], *Dany Dumont* [2], *Fred Dupont* [3], *Jean-Francois Lemieux* [3], *Youyu Lu* [4], *Bruno Tremblay* [5], *Francois Roy* [6], *Gregory Smith* [3]
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As part of the Beaufort Regional Environmental Assessment Program we describe results and direction in the project entitled “Enhancing the Canadian METAREAS operational coupled ocean-ice-atmosphere analysis and forecasting system for fine-scale applications in the Beaufort Sea“. The project objective is to improve ice and ocean models used within the Environment Canada METAREA program with particular emphasis on improving ocean and ice forecast information for the Beaufort Sea. The project is part of united Canadian approach in ocean forecasting under the CONCEPTS (Canadian Operational Network of Coupled Environmental PredicTion Systems) MOU and in collaboration with MERCATOR-Ocean.We describe project goals which include, incorporating wave-ice interaction, improving ocean model physics, adding ocean data assimilation, improving ice rheology and developing automatic validation protocols to highlight improvements to the METAREA system.Wave forecasts within the sea ice cover and information about the mean floe size will be made available the integration in the forecast system of the recent advances in waves-in-ice modeling. The ocean model will be improved through sensitivity studies in the application of tides, boundary conditions and the inclusion of fresh water run off. Data Assimilation will be achieved through modifications to the SAM2 data assimilation scheme currently applied by the CONCEPTS Global Ocean Forecast System. The project approach is to run 10 year hindcasts and historical re-forecasts of the ocean-ice prediction system to carefully evaluate the ability of the system to reproduce and predict fine-scale features of the Beaufort Sea. Preliminary results of comparison with Seal based CTD profiles observations from the first hindcast from 2002 to present will be shown. Additionally the validation methodology of the hindcast and historical forecast will be presented.

3E3.4 ID:5557 17:30

Environment Canada high resolution ice-ocean Arctic-Atlantic model: preliminary results and validation

Frederic Dupont [1], *Gregory Smith* [2], *Francois Roy* [1], *Youyu Lu* [3], *Ji Lei* [3], *Romain Bourdalle-Badie* [4]
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Environment Canada recently developed a high resolution ice-ocean model based on the NEMO model for

the Arctic and North Atlantic regions for operational oceanography purposes, called CREG12. It will encompass and replace the actual 1/12th CNOOFS system. The nominal resolution is also 1/12th but due to the refined grid close to the numerical poles of the domain (one in the Mackenzie watershed and the other one over Siberia) the actual resolution reached 2km over the western Canadian Arctic, with resolution closer to 5km elsewhere in the Arctic ocean. A first hindcast (2002-2010) of this model will be presented. Interestingly, the diagnosed 1st Rossby radius of deformation and model results both show that the scale of the eddies is smallest in the Barents Sea and Fram Strait and increases to 10-14 km in the Arctic. Hence, the main eddy activity in the Arctic is well resolved by the model. More detailed energetic analysis of the hindcast are underway. We also investigated the impact between no-slip and free-slip dynamic lateral boundary condition on transport through the Canadian Arctic Archipelago but found little impact.

3E3.5 ID:5669 17:45

Impacts of including tides in the ice-ocean modelling of the Arctic and North Atlantic Oceans

Youyu Lu [1], *Ji Lei* [1], *Frederic Dupont* [2], *Francois Roy* [2]
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In order to increase the realism of simulation and forecasting, tides are explicitly included in the ocean and sea-ice model covering the Arctic and North Atlantic Oceans based on Nucleus for European Modelling of the Ocean (NEMO). In this study, we compare the model resolutions with and without tides being included. The impacts of including tides on the simulation of sea-ice distribution, ice motion, distributions of temperature and salinity, and ocean currents are quantitatively assessed. Tidal mixing and its seasonal variation of are described.

Decision Support Meteorology (WAF) / Météorologie en support à la prise de décision (WAF)

Room / Endroit (Symphonie 2), Chair / Président (Alex Tardy), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E4.1 ID:5479 16:30

Alerting Canadians of Significant Weather Events

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The weather warning bulletins have been a fixture in the daily lives of Canadians for many years. Technological advancement (science, communication protocols, etc) is opening opportunities on how we

can alert Canadians, by moving beyond the traditional warning bulletin format. Meteorological Service of Canada (MSC) introduces Common Alerting Protocol (CAP*) format for its warnings in April 2012. Additional tools will also be introduced in its forecast operation that will bring additional changes to its warning program over the years to come. New tools, along with new data management systems, are needed in order to bring new alerting capabilities. All these changes will open new possibilities for the dissemination of warnings.

*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.

3E4.2 ID:5287 16:45

Storm? What storm? An examination of the predictability and forecast procedures associated with the Montreal snowstorm of 6-8 December 2010 and the extratropical transition of Hurricane Irene (2011)

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On 6-8 December 2010, Montreal (CYUL) received a “surprise” snowstorm that produced over 30 cm (12 in.) of snow, effectively paralyzing the city, shutting down aviation, and stranding many people overnight at their place of work. The event was magnified because Environment Canada’s Quebec Storm Prediction Centre only called for 2-4 cm of snow for the entire event. Additionally, snowfall warnings (>15 cm) were not issued until 20 cm of snow had been reported on the ground at CYUL. Upon closer examination, we found that several numerical models were consistently forecasting around 15 cm of snow for this event, an amount that meets the official snowfall warning criterion. Unfortunately, Environment Canada’s GEM model was the outlier and forecasted much lower amounts of snow. First, we will present an event overview and a synoptic-dynamic analysis of the snowstorm, using reanalysis and numerical model data. We use our results to suggest inherent systematic limitations of Environment Canada’s automated operational forecast procedures. To support this assertion, we will also discuss 3-5 day forecasts for Montreal during the extratropical transition of Hurricane Irene in August 2011, an event which resulted in heavy rainfall and strong winds throughout the province of Quebec.

3E4.3 ID:5820 17:00

Exacerbating factors for the occurrence and severity of remotely sensed Surface Urban Heat Island in Montreal, Canada, during the warm season

Philippe Martin [1], *Philippe Gachon* [1], *Yves Baudouin* [2]
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An Urban Heat Island (UHI) is a relative measure defined as a metropolitan area which is warmer than its surrounding sub-urban or rural areas. This reflects an excess in low level air temperature at a regional or local scale over surface areas in which lower albedo and higher heat capacity prevail, i.e. over building or industrial zones without vegetation. Over the last 30 years, numerous studies have gained more knowledge of this phenomenon and now also distinguish between Surface Urban Heat Islands (SUHI) at a city block scale. Hence, the main objective of the present study is to better characterize a SUHI in terms of

temperature exceedance level or threshold with respect to spatial reference and ambient meteorological conditions (i.e. used as predictors in anticipating the occurrence and severity of SUHI). A time series of images from 1984 to 2008 of Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) was used to estimate the Land Surface Temperature (LST) over the warm season in Montreal, Canada. Different SUHI categories were analyzed while considering the atmospheric conditions that prevailed before each acquisition date of Landsat imageries. Results reveal that global solar radiation (GSR) is the most relevant predictor, among other atmospheric variables, that contributes to higher heat absorption in urban landscapes. A high correlation exists between a pixel-based temperature that is 5°C hotter than the city's mean surface temperature (SUHI+5) after 24 hours of cumulative radiation. The relationships with LST or SUHI and two indices, i.e. the Normalized Difference Vegetation Index (NDVI) and Build-up index (NDBI) are also analyzed with respect to each land use category. The exacerbating factors that influence the occurrence and severity of SUHI over the Montreal area are also discussed, in order to improve the early warning system at the local scale during hot spell events.

3E4.4 ID:5666 17:15

The Negative Impact of Largely Unrecognized Superheated Surface Temperatures on Health and Activity With a Mitigation Case Study.

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Surface temperatures on a hot clear summer day are higher than most people realize and pose a significant danger to health. Weather forecasts give the expected high for the day, humidity, air quality, and UV-index but do not warn the public about the risks associated with potential high surface temperatures. A study commissioned by the Riverside Optimist Club in Windsor, in collaboration with the Public Health Units of Windsor-Essex, Sarnia-Lambton and Chatham-Kent in southwestern Ontario using LANDSAT-7 satellite imagery to measure the surface temperatures of over 800 schoolyards and public spaces found average surface temperatures ranging from 9 to 103 degrees Celsius when air temperature was just over 25 degrees Celsius. These extreme surface temperatures negatively affect health and activity. A case study of a long-running outdoor summer festival is used to show how a site was modified over time to provide a healthier environment and how long, medium, and short-term weather forecasting and better local forecast resolution can further decrease the health risk to and improve the health of attendees while enhancing their enjoyment and participation.

3E4.5 ID:5776 17:30

The use of analogs to increase forecast confidence for West Coast precipitation events

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The use of an analog approach to enhance Numerical Weather Prediction (NWP) is subjectively performed by most forecasters that have appreciable experience in pattern recognition and weather impacts. The method can be subjectively applied and highly inconsistent from forecaster to forecaster. The analog of a forecast for a given location and time can be defined as the historical event that is most similar to selected features of the current forecast. The Cooperative Institute for Precipitation Systems at Santa Louis University has been running an analog approach for the last three winters. The production was expanded in 2010 to include the Western United States and run in real-time for the 2011-12 wet season. The efforts were designed to be an additional tool for forecasters and an aide to increase forecast confidence for a

variety of precipitation events. A technique is used to produce the top 15 analogs by comparing the Global Forecast System (GFS) runs model output against the North America Regional Reanalysis dataset (available since 1979). The process quantitatively examines several levels of the atmosphere from 300 mb down to MSL to find the most similar matches. The output domain is based on the 850-mb geopotential height and contains extensive products for individual top 15 matches and individual surface impacts based on METAR, COOP and severe weather reports, the mean top 15 parameters such as unified precipitation estimates for 72-h and 120-h either side of the verification time, spaghetti plot analyses of matching events including precipitable water, and a variety of probabilistic exceedance information. The process allows for error in timing by incorporating an offset of 24 hours either side of verifying time for a current forecast cycle.

This study will demonstrate the applications of analogs for precipitation events on the West Coast and specifically as a tool to improve confidence when NWP output may be inconsistent with the given weather pattern. It will also show that analogs are an effective method to explicitly provide forecasters with a range of outcomes and to provide some validation to high impact predictions for a given GFS run. The authors recognize the limitations with using deterministic single model guidance and that the analog system is not designed to produce a perfect match that would be repackaged into the new forecast. When used in conjunction with NWP, the analog approach can be an aide for identifying when guidance is depicting an acceptable historical solution or when the forecaster must take the appropriate measures to deviate. In addition, the analog technique can accelerate learning and establish better consistency from forecaster to forecaster since the experience factor or pattern recognition is directly built into the process. Finally, the output provides a range of solutions, averaged fields and probability of exceedance guidance which can be incorporated into the forecast process to enhance confidence and skill.

3E4.6 ID:5486 17:45

The development of a prototype of a Canadian Urban Flow and Dispersion Modeling System

Pierre Bourgouin [1], *Najat Benboutat* [1], *Stéphane Bélair* [2], *Richard Hogue* [3], *Nathalie Gauthier* [4], *Eugene Yee* [5], *Fue-Sang Lien* [6], *Serge Trudel* [1], *Jean-Philippe Gauthier* [1], *Gilles Mercier* [1], *Nils Ek* [1], *Calin Zaganescu* [1]

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The possibility of a terrorist or accidental release of a Chemical, Biological, Radiological, or Nuclear (CBRN) agent in an urban environment is an increasing concern. To respond effectively to such an event, rapid decisions need to be made concerning the transport, dispersion, deposition and fate of the CBRN agent and its concomitant effects on the exposed population. The capacity of modelling the mean flow, turbulence and concentration fields in major Canadian cities would provide a key-enabling technology.

The Meteorological Service of Canada's Environmental Emergency Response Section (MSC-EERS), together with research partners, has been developing a prototype to build that capacity under funding from Defense Research and Development Canada' CBRN Research and Technology Initiative (CRTI). The resulting prototype is a multi-scale modeling system designed to model the mean flow, turbulence and concentration fields in urban areas, called the Canadian Urban Flow and Dispersion Modeling (CUDM) system.

The CUDM system includes a meteorological urbanized meso-scale model (UrbanGEM) used to drive a micro-scale Computational Fluid Dynamics (CFD) flow model (UrbanSTREAM). The micro-scale model simulates the mean wind and turbulence fields to feed both an Eulerian dispersion model (UrbanEU) and a Lagrangian Stochastic dispersion model (UrbanLS). These dispersion models produce predictions of concentration fields resulting from releases of contaminants, such as CBRN agents.

The CUDM system was tested for a number of CBRN scenarios in several major Canadian cities. This extensive testing was done to make the prototype more robust, to build EERS expertise on using it and to define the associated operational procedures. The system can be used for CBRN pre-event scenario planning, real time emergency response and post-incident assessment. Results from these different experiments will be presented along with a description of the CUDM system.

Climate Change and the Carbon Cycle PART 1 / Changements climatiques et le cycle du carbone PART 1

Room / Endroit (Symphonie 3A), Chair / Président (Jean-Sebastien Landry), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E7.1 ID:5642 INVITED/INVITÉ 16:30

Will deforesting Canada cool the climate?

Alvaro Montenegro [1], *Patrick Longobardi* [1], *Hugo Beltrami* [1], *Gurpreet Matharoo* [1], *Michael Eby* [2], *Quiazhen Mu* [3]

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Deforestation impacts climate on local to global scales by changes in the energy and mass fluxes between the land surface and the atmosphere. Deforestation is frequently associated with carbon emissions due to CO2 release from felled trees and ecosystem changes affecting total carbon storage. Removal of trees also causes changes to surface albedo and evapotranspiration. Croplands and pastures tend to have higher albedo than forests and, given the shallower roots of crops and grasses, deforestation usually decreases local evapotranspiration and latent heat flux into the atmosphere. In models the net temperature response to deforestation is, to a large extent, determined by the magnitudes of these opposing warming (higher atmospheric CO2 and lower latent heat flux) and cooling (increased albedo) effects. Simulations tend to show that high-latitude deforestation results in cooling, with the temperature response dominated by the albedo effect. The reduction in temperature is global and, on land, concentrated over the deforested areas. Most modeling experiments so far have analyzed the response to large-scale land cover change. There have been recent indications from satellite based and modeling studies that the temperature response is dependent on the scale and location of land cover change and that in many high-latitude areas

deforestation would result not in cooling but in net warming. This uncertainty is not restricted to the temperature response. Recent model results show a decrease in atmospheric CO2 after high-latitude deforestation due to an increase in soil carbon storage. Relatively recent satellite and in situ observations have significantly increased the spatial and temporal resolution at which we are able to analyze many of the land surface parameters pertinent to the deforestation problem. These new data will be of great benefit to both the modeling and observational communities as we try to solve the uncertainties associated with the climate response to deforestation.

3E7.2 ID:5774 INVITED/INVITÉ 16:45

Can high-latitude afforestation help mitigate global warming?

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Planting trees to remove atmospheric CO2 or to produce bioenergy has been questioned recently because increased tree cover may also reduce surface albedo. Tree cover certainly increases roughness and shadow effects, but plantations can take many forms. In central Canada, there is significant interest in establishing large areas of fast growing deciduous species (poplars and willows) at wide spacing and harvested on 15–20 year rotations. The objective is to offset impending wood supply shortages from natural boreal stands. Such stands are generally slow-growing and densely spaced, often with high proportions of dark evergreen conifer, so have characteristically low surface albedo compared to grassland or cropland, particularly in winter. Here we report measurements at an operational hybrid poplar plantation established in central Alberta in spring 2005. Over seven growing seasons, the land surface has transitioned from completely bare to ~7 m trees, and there have been major changes in CO2 uptake, strongly correlated to variations in annual precipitation. Energy balance closure has remained within ±10%. However, there appear to be no systematic changes in the average winter albedo measured above the canopy. These results suggest feedbacks of fast-growing deciduous plantations on radiative forcing are likely to be minimal. Even if albedo decreases as the plantation grows taller, the short rotation means a relatively small fraction of total plantation area will be affected. In determining the net impacts of plantation forestry on radiative forcing, we must also consider the CO2 accumulated in biomass and soil, while taking account of emissions due to management operations and harvesting. Realistically, the net contributions of afforestation to mitigating global GHG emissions are likely to be small, even if reduced albedo is not an issue. For the future, however, our results also point to possible impacts of warmer, drier conditions that will reduce both CO2 uptake and average winter albedo.

3E7.3 ID:5730 17:00

A possible abrupt change in the land uptake of carbon in 1989

Claudie Beaulieu [1], *Jorge L. Sarmiento* [1], *Sara E. Mikaloff Fletcher* [2], *David Medvigy* [1], *Jie Chen* [3]

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A recent study of the net land carbon sink suggests that the net land carbon uptake abruptly increased after 1988/1989. The net land carbon uptake is estimated as a balance between the fossil fuel emissions, the atmospheric growth rate of CO2 at Mauna Loa and South Pole and ocean uptake estimates from a suite of ocean models. Due to the large variability in the land uptake of carbon, the nature and exact time of this increase is difficult to identify. Here we use a change point detection technique, which is designed to detect

the timing and magnitude of level shifts in time series and to discriminate between several types of changes (e.g. constant mean, abrupt shift in the mean, linear trend or linear trend with a level shift). We confirm that it is likely that an abrupt shift in the mean of the net land uptake of carbon occurred in 1988. After taking into account the variability in the net land uptake of carbon due to the influence of volcanic aerosols and the El Niño Southern Oscillation, we find that there is a step increase of about 1 Pg C/yr in 1988. We also find that it is likely that the atmospheric growth rate of CO2 exhibits a level shift in 1988 of approximately -1 Pg C/year, which is most likely due to the shift in the net land uptake of carbon.

3E7.4 ID:5495 17:15

Assessing the impact of late Pleistocene megafaunal extinctions on global vegetation and climate.

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The end of the Pleistocene marked a turning point for the Earth system, as climate gradually emerged from millennia of severe glaciation in the Northern Hemisphere. It is widely known that the deglacial climate change then was accompanied by an unprecedented decline in many species of large terrestrial mammals, featuring among others the near-total eradication of the woolly mammoth. Due to a herbivorous diet that involved the grazing of a large number of trees, their extinction is thought to have contributed to the rapid and well-documented expansion of dwarf deciduous trees in Siberia and Beringia, which in turn would have resulted in a significant reduction in surface albedo, leading to an increase in global temperature.

In this study, we use the UVic ESCM to simulate various scenarios of the megafaunal extinctions, ranging from the catastrophic to more realistic cases, in order to quantify their potential impact on the climate system, and investigate the associated biogeophysical feedbacks between the growing vegetation and rising temperatures. Due to insufficient information pertaining to mammoth diet and habitat, we decided to test the sensitivity of the climate system to a broad range of parameters such as the rate of tree clearing and southernmost extent of habitat. Overall, the results of the paleoclimate simulations and the sensitivity tests correspond well with our intuition, with a global averaged warming of up to 0.15 C after 500 model years.

As a second component of the study, we examine the biogeochemical effects that occur when there is free interaction between atmospheric carbon dioxide and other components of the model. While we expected CO2 levels to drop due to increased photosynthesis rates, model results display a clear opposite trendency, resulting in a nearly doubled elevation of surface temperatures when compared to a simulation with prescribed levels of atmospheric CO2.

Regional Climate Modelling and Climate Projections PART 6 / Modélisation du climat régional et projections du climat PARTIE 6

Room / Endroit (Symphonie 3B), Chair / Président (J.P.R. Laprise), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E6.1 ID:5681 INVITED/INVITÉ 16:30

Impact of regional climate model configuration on simulating tropical systems

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We will present an overview of the Canadian regional climate model's performance in simulating the climatology and variability of certain tropical systems. More specifically, we will evaluate the ability of the regional climate model to capture observed number, geographical distribution, intensity distribution, seasonal and interannual variability of Atlantic tropical cyclones, and African easterly waves, the latter often serving as precursor systems to intense Atlantic hurricanes.

By comparing and contrasting a series of integrations originating from a range of model configurations, we can begin to understand the importance of various factors on simulations performed over tropical areas. These factors include i) resolution, ii) domain size and boundary location (e.g. inclusion of a high-resolution representation of African easterly wave tracks on tropical cyclone activity), iii) the importance of employing reanalysis versus global climate model as lateral and lower boundary conditions and iv) treatment of LAM lateral boundary conditions compared to the open-boundary (global model, variable resolution approach).

The results derived from this intercomparison will be used to highlight the difficulties associated with using a regional climate model to project future changes in the statistics of Atlantic tropical cyclone activity.

3E6.2 ID:5514 17:00

Evaluation of CMIP5 models and regional climate ensembles for historical western Atlantic winter storms and their future predictions

Brian Colle , *Ping Liu* , *Zhenhai Zhang* , *Kelly Lombardo* , *Minghua Zhang* , *Edmund Chang* , *Sultan Hameed*
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The eastern United States is particularly vulnerable to coastal winter storms, since they frequently impact this populated region. The ability of atmosphere–ocean general circulation models (AOGCMs) to accurately simulate cool season extratropical storms and any trends is of great importance. The late 20th century simulations generated by the CMIP5 Project are analyzed to evaluate their potential in simulating coastal storm frequency and intensity over eastern North America and the western Atlantic Ocean during the cool season (Nov-March). Since the many of the CMIP5 models are run at > 100-km grid spacing, the results are compared with higher resolution regional climate models from NARCCAP (50-km grid spacing) as well as the Weather Research and Forecasting (WRF) ensemble nested down to 20-km grid spacing within the CCSM. The density, intensity and decadal variations of observed cyclones were obtained using Climate Forecast System Reanalysis.

The historical cyclone predictions from 1979-2002 for at least 9 CMIP5 members have been evaluated using 6-h SLP data. The extratropical cyclones are tracked using the approach by Hodges (1994). The parameters chosen and associated cyclone tracks were manually validated over several Januarys, which yielded a ~90% accuracy in cyclone detection and a < 10% false alarm. Preliminary results suggest that many CMIP5 models underpredict the number and intensity of cyclones during the cool season around eastern North America. Horizontal resolution may not be the only issue with CMIP5, since many of the

NARCCAP members also underpredict cyclone frequency over the western Atlantic by 20-30%. Several WRF runs forced by the NCEP reanalysis or CCSM are used to determine some of the reasons for this underprediction using different model physics, SST, and grid resolutions. Some future predictions will also be shown, with more weight given to those ensemble members with the largest historical skill.

3E6.3 ID:5753 17:15

Possible North Atlantic extratropical cyclone activity in a warmer climate

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In this study, the impact of greenhouse gas (GHG)-induced global warming on the North Atlantic (NA) storm climate is investigated by using dynamically downscaled outputs from Canadian Regional Climate Model (CRCM). The downscaling simulations were performed with CRCM driven by estimates from simulations of the third Generation Coupled Global Climate Model (CGCM3.1) following the Intergovernmental Panel on Climate Change (IPCC) 20th Century (20C3M) (1970-1999) and SRES A1B Scenario emissions (2040-2069) simulations. We show that CRCM can capture the general characteristics of the storm tracks and wind fields suggested by the reanalysis data for the current climate over the North Atlantic (NA) area. Compared with CGCM3's results, CRCM gives improved estimates of the distribution of storm tracks with respect to reanalysis data, although it still tends to underestimate the track density over the Northwest Atlantic area. For the high-CO2 A1B climate change scenario, both CRCM and CGCM3 show that there is a small reduction in the total number of cyclones, but an increase in the most intense ones. Similar to previous studies, in future climate estimates, simulations also show that the dominant North Atlantic storm tracks shift northward, especially over the northern Northeast Atlantic, where the occurrence of the most intense cyclones (with minimum mean sea level pressure below 970hPa or maximum winds 27 m/s) increases. However, over the NA mid-latitudes, the storm density decreases, and the occurrence of the most intense cyclones also slightly decreases during 2040-2069. The storm density changes are connected with changes in the mean upper level steering atmospheric flow. In terms of storm structure, composite analyses of the most intense cyclones show that they tend to become larger and more intense in the A1B climate change scenario.

3E6.4 ID:5309 17:30

Feasibility study of a very high resolution Regional Climate Model

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This study proposes to apply the grid telescoping method to the Canadian Regional Climate Model (CRCM5) in order to carry a feasibility test of a very high resolution climate model. Dynamical downscaling is applied as many times as needed to get the desired fine resolution. All integrations are driven by the results of a previous one with coarser mesh. The computational cost of the simulations is kept within acceptable limits by successively reducing the size of the limited area domain, and by simulating only episodes rather than continuous integration. Using this approach, resolution can be increased by nearly two folds without undue computational cost increase. Atmospheric fields' variance spectra are used to study both the temporal spin-up and the spatial spin-up, and to better understand the contribution of the increased resolution to the added value of very high resolution. This work is a first step in preparation for the next generation of high resolution (order of one kilometer mesh) climate models.

3E6.5 ID:5325 17:45

A regional ocean climate model for the British Columbia continental shelf

<u>Michael Foreman</u> , *Wendy Callendar* , *Diane Masson* , *John Morrison* , *Isaac Fine*
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A regional, ocean-only, climate model for the British Columbia continental shelf has been developed and run with downscaled IPCC-AR4 A2 future scenario results from global and regional climate models. The 3 km shelf model takes its future atmospheric forcing from the Canadian regional, atmosphere-only, climate model and estimates future coastal freshwater discharges in twenty-two sub-basins by downscaling the precipitation, temperature and snowpack projections provided by this same regional model. Initial and lateral boundary oceanic conditions for salinity and temperature are computed by adding anomalies from the Canadian global climate model to more highly-resolved present-day fields. Model results will be presented and both future work and the possible impact on regional ecosystems will be briefly discussed.

Ensemble prediction PART 1 / Ensembles de prévisions PARTIE 1

Room / Endroit (Symphonie 4), Chair / Président (R Bruce Telfeyan), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E1.1 ID:5650 16:30

The Canadian regional ensemble prediction system (REPS). Current and future products

<u>Ronald Frenette</u> , *Nedka Pentcheva* , *Amin Erfani* , *Stephane Beauregard* , *Normand Gagnon* , *Martin Charron*
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The Canadian REPS has been running operationally at the Canadian Meteorological Center (CMC) since September 2011. Several ensemble products derived from the numerical outputs of this system are already available to forecasters. The REPS horizontal resolution is expected to increase from its current 33km to 15 or 20km in the fall of 2012. The number of horizontal levels will also grow from 28 to 40-48. This new system with a higher resolution will likely become an important numerical weather forecasting tool for day 1 to 3. Development on the next generation of probabilistic outputs is now under way. A special attention on winter and summer significant events will be put into these new products. Information and examples on the current and future development of these REPS products will be presented.

3E1.2 ID:5698 16:45

Multi-scale ensemble data assimilation and model error investigation with NOGAPS and WRF

<u>Walter Kolczynski</u> , *Joshua Hacker*
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Following earlier work implementing the Navy Operational Global Atmospheric Prediction System (NOGAPS) into the Data Assimilation Research Testbed (DART), we present results from regional mesoscale ensemble data assimilation with the Weather Research and Forecasting (WRF) model in DART. The combination of NOGAPS and WRF, embedded within the same data assimilation system, enables mesoscale ensemble data assimilation and prediction ensemble sizes limited only by computational resources. Each WRF ensemble member can be driven by a single NOGAPS ensemble member. Large-scale error growth is simulated by the global ensemble and passed to the regional ensemble via the lateral boundary conditions (LBCs). The combination mitigates the need for random LBC perturbations to maintain LBC spread. Perhaps more importantly the large-scale uncertainty growth enables mesoscale ensemble prediction for longer lead times when large scales dominate the uncertainty. The capability allows for various inquiries into the effects of LBC on regional error growth, the role of large-scale forcing on local predictability, among other topics.

We use the DART-NOGAPS-WRF system to investigate the leading structures of model error in the WRF. Because the ensemble spread indicates internal chaotic dynamics, comparing an Observation System Simulation Experiment (OSSE) to assimilation with real observations permits separation of the chaotic error growth from systematic error growth owing to model inadequacy.

Our presentation will describe the DART-NOGAPS-WRF system, some verification, and some results from the model-error analysis.

3E1.3 ID:5616 17:00

Analog Ensemble for Probabilistic Weather Predictions

<u>Luca Delle Monache</u> [1], *F. Anthony Eckel* [2], *Badrinath Nagarajan* [1], *Daran Rife* [3], *Keith Searight* [1], *Don Berchoff* [2], *Martin Charron* [4], *Ronal Frenette* [4], *Jason Knievel* [1], *Tim Mcclung* [2]
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A new ensemble design based on a set of analog forecasts is proposed (analog ensemble, AnEn). The analog of a forecast for a given location and time is defined as the observation (or analysis grid point) that verified when a past prediction matching selected features of the current forecast was valid. The analogs are generated from the Environment Canada Global Environmental Multiscale Model (GEM) model deterministic run, and 10-m wind speed and 2-m temperature observations from 592 surface stations over the continental U.S., for a 15-month study period (1 May 2010 - 31 July 2011). Attributes of the 0-48 h probabilistic prediction of 10-m wind speed and 2-m temperature generated with AnEn are estimated and compared to a state-of-the-science operational system, the Environment Canada Regional Ensemble Prediction System (REPS).

AnEn exhibits better spread-error and statistical consistency, reliability, resolution, and value of the raw REPS system, while it exhibits a lower sharpness. Even after the REPS is calibrated, AnEn has superior or similar skill across the forecast lead times and for different events. The AnEn is based on a very simple approach that makes the whole procedure of generating probabilistic predictions extremely cost-effective (e.g., the real-time processing of AnEn is about three times cheaper than REPS), while producing a skill-level superior or similar to a calibrated state-of-the-science system, as REPS. The implication of these results will be discussed.

3E1.4 ID:5381 17:15

Mismatching perturbations at the lateral boundaries in limited-area ensemble forecasting

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Using an experimental convection-permitting ensemble prediction system (EPS) recently developed at the Met Office where the analysis uncertainty is estimated by means of an ensemble transform Kalman filter (ETKF), we will present a case study where gravity wave activity triggered by mismatches between the analysis perturbations and the perturbations coming from the lateral boundaries led to the generation of significant spurious perturbations in the ensemble forecasts of the surface pressure. To alleviate ensemble perturbation mismatches originating from the ensemble technique, we tested a so-called scale-selective ETKF where a revised transform matrix is applied only to the small-scale component of the high resolution forecasts while the large-scale component of the analysis perturbations is taken from the driving EPS. Results showed that the new approach successfully removed the spurious perturbations in the surface pressure fields and also allowed some benefits in the precipitation forecasts for the case studied. An examination of ensemble-derived forecast error covariances revealed that ensemble perturbation mismatches at the lateral boundaries tend to decrease the degree of balance between the mass field and the rotational wind field and to produce more compact horizontal and vertical correlations. Finally, the limitations of the scale-selective approach and future directions will be discussed.

3E1.5 ID:5466 17:30

A comparison of ensemble perturbations generated by breeding and ensemble Kalman Filter schemes

Xiaqiong Zhou [1], *Yuejian Zhu* [1], *Dingchen Hou* [1], *Fuqing Zhang* [2]
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ABSTRACT

The ensemble transformation (ET) scheme resembles the breading method in that they both dynamically cycle the fastest growing non-linear perturbations. Meanwhile, the ET is consistent with data assimilation systems as the perturbations are constrained by the initial analysis error variance. Ensemble Kalman Filter (EnKF) explicitly evolves an ensemble over data assimilation, which is updated at successive observation times. The ensemble obtained at the end of the assimilation can directly used as the initial conditions for global ensemble prediction. The primary goal of this study is to perform the comparison of these two ensemble initialization schemes. A preliminary study has indicated that initial perturbations from EnKF is relatively large but ensemble forecast lacks error growing for extended range compared with the ET technique. It may suggest the importance to have additional ETR process (or hybrid) to EnKF analyses in order to generate optimum initial vectors. A further comparison of the current operational GEFS (BV/ETR initialization/cycling) and EnKF (initialization and cycling) will be performed in terms of 1) forecast error-spread ratio; 2) perturbation versus Error Correlation Analysis (PECA) forecast; 3) the growing of forecast perturbations and 4) power spectrum analysis for different wave length.

3E1.6 ID:5511 17:45

Development of a real-time ensemble sensitivity tool to assess the predictability of high impact weather during the cool season

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Stony Brook University has been collaborating with several NWS offices and NCEP operational centers on a CSTAR project focusing on the predictability of high impact weather (http://dendrite.somas.stonybrook.edu/CSTAR/cstar.html). We have implemented an ensemble sensitivity analysis approach (Torn and Hakim 2008; 2009) to improve forecaster awareness of upstream error development and uncertainty. This tool can highlight the upstream source regions where initial condition uncertainty leads to ensemble spread within a downstream boxed region (e.g. nor-easter cyclone along the East coast). Ensemble sensitivity is a correlation between a forecast metric at the final forecast time and any variable within the model state vector. We have modified the approach to include forecast metrics more suitable to the forecaster, such as determining the upstream sensitivity associated with cyclone position and strength. This is done using Empirical Orthogonal Function (EOF) analysis on the variance of ensemble sea-level pressure forecasts around a cyclone. The approach can also be run forward in time by first obtaining an ensemble mean error within a boxed region early in the forecast (e.g., 24-h 500 Z error). The ensemble sensitivity approach has been applied to high impact weather events with large ensemble spread over the Northeast U.S. using the NCEP, CMC, and ECMWF ensembles, such as the 26-27 December 2010 NYC blizzard and hurricane Irene (26-28 August 2011). For the 26-27 December event, this talk will highlight some of the upstream sensitive regions that may have led to the dramatic shift in model cyclone tracks towards the coast between the 24th and 25th December model cycles. Also, this ensemble sensitivity tool is now available in realtime to the forecaster. The forecaster can select a region of interest and particular forecast metric, and then the tool will calculate the upstream sensitive regions.

Weather case studies PART 2 / Études de cas météorologiques PARTIE 2

Room / Endroit (Ovation), Chair / Président (Andrea Lang), Date (31/05/2012), Time / Heure (16:30 - 18:00)

3E2.1 ID:5481 INVITED/INVITÉ 16:30

Analysis of the Impact of Supplemental Dropwindsonde and Rawinsonde Observations on Model Track Forecasts of Hurricane Irene (2011)

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As Hurricane Irene approached the east coast of the United States in August 2011 a large number of supplemental observations were taken in an effort to improve operational analyses and model forecasts of the cyclone. The NOAA Gulfstream-IV jet flew 10 synoptic surveillance missions from 23-27 August and deployed between 22 and 36 dropwindsondes during each mission to collect data near and upstream of Irene, while one surveillance mission was flown by an Air Force Reserve C-130 aircraft on 23 August. In addition, supplemental 0600 and 1800 UTC rawinsondes were launched beginning at 1800 UTC 22 August from upper-air stations in the southeastern United States. Then, in an unprecedented move the coverage of the supplemental rawinsondes was then expanded to include all of the continental United States from the Rocky Mountains eastward beginning at 0600 UTC 25 August in an effort to better sample synoptic-scale flow features upstream of Irene. In an attempt to quantify the impact of these supplemental data, data denial studies were performed for the dropwindsonde and supplemental rawinsonde observations. Analyses were created excluding the dropwindsonde and supplemental rawinsonde observations individually and then together using the National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) data assimilation scheme. The NCEP Global Forecast System (GFS) and Hurricane Weather Research and Forecasting (HWRF) models were run using the GSI analyses that excluded the supplemental observations. Differences between the operational GFS and HWRF forecasts and the "data-denial" forecasts will be used to quantify the impact of the supplemental observations on the track forecast of Irene in both models.

Results suggest a small but overall positive improvement due to both the dropwindsonde and supplementary radiosonde observations on the track of Irene in the GFS. The dropwindsonde data showed the largest improvement in 2 to 3 day forecasts, while the supplemental rawinsondes showed the largest improvement at days 4 and 5. The supplemental data resulted in little change to the track of Irene in the HWRF model through day 3 and some degradation to the track at days 4 and 5.

3E2.2 ID:5324 17:00

Inondations et éboulements sur la péninsule sud d'Haïti en absence de système tropical les 10 et 11 octobre 2011

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Le terrible séisme du 12 janvier 2010 a considérablement affaibli les services météorologiques d'Haïti. Pour aider à remédier à la situation, le Service Météorologique du Canada (SMC), MétéoFrance et UK-MetOffice ont accepté de fournir des prévisions météorologiques de soutien à Haïti. Le déploiement de météorologistes canadiens en Martinique en appui au Centre national de météorologie d'Haïti s'est déroulé durant les saisons cycloniques de 2010 et de 2011. En 2011, les services sanitaires d'Haïti sont particulièrement inquiets de la menace causée par le retour de la saison cyclonique (onde tropicale, dépression tropicale, tempête tropicale, ouragan). On s'attend à ce que les fortes pluies associées à ces systèmes tropicaux jouent un rôle important sur l'éventuelle résurgence du choléra au sein d'une population fragilisée. Les 10 et 11 octobre 2011, en l'absence de tout système tropical, de fortes pluies s'abattent continuellement sur la péninsule sud d'Haïti. De nombreux cas de choléra apparaissent alors dans la région. Des inondations et des éboulements ont isolé certaines communautés du reste du pays, compliquant l'apport des soins à la population. Cette présentation mettra en lumière les conditions atmosphériques menant à la formation de ces pluies continues : une circulation persistante du sud forçant de l'air très humide et instable à se soulever le long de la barrière du massif de la Hotte. Des orages se sont formés et intensifiés de façon soutenue sur le secteur pendant près de 36 heures. On estime à au moins 200 mm les quantités de pluie tombées sur le secteur. L'absence de système tropical (onde, tempête, cyclone) a rendu difficile le traitement obtenu par les modèles numériques français CEP et américain GFS. L'approche utilisée dans le cadre du travail de prévision s'est apparentée beaucoup plus aux techniques de prévision de convection des latitudes moyennes qu'à celles des latitudes tropicales.

3E2.3 ID:5578 17:15

Case Study of an Intense Winter Storm over Newfoundland

Devon Telford , *Marshall Hawkins* , *Rob Harris*
(Presented by *Rob Harris*)
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An intense winter storm on December 8-9th, 2011 caused high storm surges, high seas and record setting high winds along the west coast of Newfoundland. A particular observation – a peak wind of 124 kt, or 230 km/hr - was recorded at Ferolle Point (CWXI) near 0000 UTC on December 9th. These extreme conditions damaged property and local infrastructure. Large vessels were blown ashore, boats in dry dock damaged and damage resulted to housing in the area. The forecast challenges, methods and tools applied to this storm by the Newfoundland and Labrador Weather Office are discussed.

3E2.4 ID:5834 17:30

An examination of the various FIM model configurations and other NWP guidance for an historic high-impact snowstorm in the Northeast U.S. in late October 2011

Ed Szoke [1], *Stan Benjamin* [2], *John Brown* [2], *Mike Fiorino* [2], *Susan Sahm* [2], *Brian Jamison* [1]
(Presented by *Edward Szoke*)
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For the last several years the Global Systems Division (GSD) of NOAA/ESRL has been developing a new global model known as the FIM, for Flow-following finite-volume Icosahedral Model. In addition to the icosahedral horizontal grid, other differences between the FIM and current operational global models, such as the Global Forecast System (GFS) and the European Centre for Medium-Range Weather Forecast model (ECMWF), include an adaptive isentropic-sigma hybrid vertical coordinate that is used in the FIM. At GSD we have been running a number of different versions of the FIM, testing both assimilation techniques and various horizontal grid resolutions. A potential future role for the FIM is to become a part of the North American Ensemble Forecast System (NAEFS), along with the current members from the GFS and the Meteorological Service of Canada Global Model.

A companion paper by Brown et al. will give an overview of the FIM. In this talk we will focus on longer to medium range forecasts for an early season Nor'Easter that brought historically heavy snows in a swath from Pennsylvania to New England, with numerous early-season snowfall records easily toppled. Coupled with a relatively late leaf drop during a very wet autumn, the storm was quite destructive, with millions losing power, some for over a week. While a potential storm was seen in some of the forecasts over a week in advance, this ended up being a very challenging prediction, with considerable model forecast variability that included the storm moving harmlessly out to sea. Forecasts will be examined from a number of operational models, including the GFS, ECMWF, GEM, and UKMO, and compared to predictions from the various versions of the FIM. Ensemble forecasts from the NAEFS will also be examined, with an eye towards whether the FIM could have made a positive contribution.

Plenary Day 4 / Plénière jour 4

Room / Endroit (Grand salon), Chair / Président (Denis Gilbert), Date (01/06/2012), Time / Heure (08:30 - 10:00)

P4.1 ID:5566 INVITED/INVITÉ 08:30

Implementing a 3D-VAR data assimilation system in the Met Office's ocean forecasting system.

Matthew Martin , *Daniel Lea* , *Jennifer Waters* , *James While*
UK Met Office
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The Met Office's Forecasting Ocean Assimilation Model (FOAM) has been run as a global operational system since 1997. The model produces analyses and forecasts of temperature, salinity, currents, sea surface height and sea ice. FOAM is run operationally in a global configuration at ¼ degree resolution as well as in three nested regional configurations; the North Atlantic, Indian Ocean and Mediterranean models, all at 1/12 degree resolution. The products are used by the Navy, commercially and for research purposes. Since 2008 the hydrodynamic model in FOAM has been the Nucleus for European Modelling of the Ocean (NEMO) model.

We are currently updating the data assimilation scheme in NEMO to a 3D-VAR system, NEMOVAR. This new system will be used for operational ocean forecasting in FOAM, and to produce initial conditions for the ocean component of coupled ocean/atmosphere forecasts out to seasonal time-scales. NEMOVAR is a multivariate incremental variational data assimilation scheme and is developed in collaboration with CERFACS, ECMWF and INRIA/LJK. The system assimilates in situ and satellite sea surface temperature (SST) data, temperature and salinity profile data from Argo floats and other sources, satellite altimeter sea level anomaly (SLA) data and sea ice concentration data. The system also includes an SST observation and altimeter bias correction scheme.

We will describe the implementation of NEMOVAR at the Met Office and will give an overview of the system. We will discuss how the different data types are assimilated in a coherent way using the balance relationships and will describe the specification of the error covariances. Developments to the bias correction of altimeter data will also be described. Results from a NEMOVAR reanalysis will be discussed, including comparison to observations and results from our previous system.

P4.2 ID:5908 INVITED/INVITÉ 09:15

Impact of ongoing climate change on Arctic marine ecosystems

Marcel Babin
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The ongoing decrease in perennial ice and increase in rivers discharge will strongly impact on Arctic marine ecosystems and, notably, on biomass production by phytoplankton. But how biomass production will evolve over the next decades is highly uncertain. While ice receding will allow more solar radiation to penetrate the water column and fuel photosynthesis, enhanced vertical stratification may prevent the injection of the new nutrients needed to support additional algal growth in the lit layer. The biodiversity, which already shows latitudinal shifts, will play a central role in the response of Arctic marine ecosystems to climate change. In this talk, I will overview the modifications in the Arctic marine environment that are relevant to living organisms, and the resulting ongoing changes observed in Arctic marine ecosystems. Also, I will present results obtained using ocean color remote sensing to analyze the spatial and temporal variations in primary production over the whole Arctic Ocean.

Ensemble prediction PART 2 / Ensembles de prévisions PARTIE 2

Room / Endroit (Grand salon A), Chair / Président (R Bruce Telfeyan), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B3.1 ID:5368 10:30

Optimization of the Analog Ensemble Method

Tony Eckel [1], *Luca Delle Monache* [2], *Daran Rife* [3], *Badrinath Nagarajan* [2], *Don Berchoff* [4], *Martin Charron* [5], *Ronald Frenette* [5], *Jason Knievel* [2], *Tim Mcclung* [4], *Keith Searight* [2]

[1] US National Weather Service

[2] National Center for Atmospheric Research

[3] Garrad Hassan

[4] NWS Office of Science and Technology

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An analog ensemble is constructed by matching up the current forecast from a numerical weather prediction model to similar past forecasts, then using the past verifying observation (or gridded analysis) from each match as an ensemble member. Recent work demonstrated that an analog ensemble is a cost-effective method to produce highly skilled probabilistic forecasts. This follow-on study investigates various aspects of analog ensemble design optimization including: a) The best ensemble size is primarily dependent upon the length of the training dataset. As training data is decreased and/or the number of members is increased, many weak analogs are included, thus creating an overspread condition. Using too few members reduces skill as the error in the ensemble mean increases and the ensemble becomes underspread. b) Longer training periods obviously increases skill, but incur costs of generating a reforecast dataset. However, even fairly short training periods can produce skilled predictions. c) Skill can be improved by accounting for the relative strength of the analogs when generating probabilistic predictions. d) Careful selection of predictor variables and their relative weights are important factors in the analog search. e) In the grand scheme, maximum efficiency and skill may come from a hybrid configuration where m analogs are found for each member of a small n-member NWP ensemble, to produce a total of mXn members.

4B3.2 ID:5644 10:45

New Development in CAPS Storm-Scale Ensemble Forecasting System for the NOAA Hazardous Weather Testbed Spring Experiment

Fanyou Kong [1], *Ming Xue* [2], *Kevin, W. Thomas* [1], *Yunheng Wang* [1], *Keith Brewster* [1], *Xuguang Wang* [2], *Steven J. Weiss* [3], *Adam Clark* [4], *Mike C. Coniglio* [4], *John S. Kain* [4], *Jimmy Correia* [3], *Patric Marsh* [4]

[1] Center for Analysis and Prediction of Storms, University of Oklahoma

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Every Spring since 2007, the Center for Analysis and Prediction of Storm at University of Oklahoma produced multi-model storm-scale ensemble forecasts (SSEF) in realtime in support of the NOAA Hazardous Weather Testbed (HWT) Spring Experiment. In past years, the CAPS SSEF was run once daily initiated at 0000 UTC producing up to 36 hours of storm-scale probabilistic forecasts. In 2012 NOAA HWT Spring Experiment from April 23 to June 07, 2012 , the CAPS SSEF runs twice daily, adding a 1200 UTC initiation, with 15-member 36-h baseline ensemble forecasts. The 0000 UTC initialized SSEF consists of 25 multi-model multi-physics ensemble members using four NWP modeling systems (WRF-ARW, WRF-NMM, ARPS, and COAMPS). The 1200 UTC addition of ensemble allows the assessment of skillfulness of morning initiation against 0000 UTC initiation to the severe storm probabilistic guidance. Among the newly added products, the NESDIS/JCSDA Community Radiative Transfer Model (CRTM) is applied to produce simulated synthetic GOES-R infrared imagery, as part of upgraded real-time post-processing package in supporting the GOES-R Proving Ground Project, for all individual ensemble members as well as probabilistic imagery products. The experimental convection initiation (CI) and lightning threat products are refined/recalibrated based on evaluations from 2011 Spring Experiment dataset. System configuration, experiment status, examples of new products and preliminary evaluations will be presented on the conference.

4B3.3 ID:5539 11:00

The current and future development of the Regional Ensemble Prediction System

Amin Erfani [1], *Ronald Frenette* [2], *Normand Gagnon* [1], *Martin Charron* [3]
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[3] Recherche en prévision numérique atmosphérique, Meteorological Research Division.
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A Regional Ensemble Prediction System (REPS) has been running operationally at the Canadian Meteorological Center (CMC) since September 2011. The dynamical core of the REPS is the limited-area version of GEM with 33 km horizontal resolution and 28 levels at the vertical. The physics is almost identical to the operational Global Deterministic Prediction System (GDPS) which currently has the same resolution as the REPS. The system is initialised by a global ensemble Kalman filter (EnKF). The horizontal boundary conditions are provided by a Global Ensemble Prediction System (GEPS). The system is also nested at the lid by the GEPS. A 72 hour ensemble forecast, with 20 members, is performed using a single model configuration with stochastic perturbations of physical tendencies. Currently development work is under way to increase the horizontal and vertical resolution of the REPS. Experiments are being performed at 15 to 20 km horizontal grid spacing with 40 to 48 levels at the vertical. The physics of the model is planned to be identical to a new 25 km horizontal resolution GDPS model that is expected to become operational in fall of 2012. The REPS at higher resolution will serve as a complimentary prediction system to a new 10 km horizontal resolution Regional Deterministic Prediction System (RDPS) that is planned to be implemented in operations during the summer of 2012. This presentation will provide information on the current and the future development of the REPS.

4B3.4 ID:5418 11:15

Experiment of Multi-physics Global Ensemble System

Yuejian Zhu , *Weiyu Yang* , *Dingchen Hou* , *Shrinvas Moorthi* , *Mark Iredell*
EMC/NCEP/NWS/NOAA
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NCEP Global Ensemble Forecast System (GEFS) has been in operation since 1992. In past 20 years, there were many developments following initial perturbed method (breeding vectors in pairs) was introduced by Toth and Kalnay (Toth et al, 1993); then ensemble transform with rescaling (ETR) for BV was applied in 2006 (Wei and et al, 2008); later Stochastic Total Tendency Perturbation (STTP) was implemented in 2010 (Hou and et al, 2012) to increase ensemble forecast spread. However, ensemble forecast is still under dispersing for lower atmosphere and extended range due to model imperfection and physical parameterization. In particular, forecasts are outlier of ensemble envelop for extreme weather events. Recently, a various schemes, which include deep convection, shallow convection, PBL, micro-physics and etc…, have been designed to simulate multi-physics with initial perturbed GEFS at current operational configuration (T254L42 for 0-192 hours, T190L42 for 192-384 hours). Through a set of experiments, the results will be examined for different forecast ranges, and various weather forecast systems.

4B3.5 ID:5331 11:30

Investigating False Alarm Mesoscale Convective Systems with the 2010 CAPS Real Time Storm-Scale Ensemble

Timothy Marquis [1], *William Gallus* [1], *Ming Xue* [2], *Fanyou Kong* [2], *Adam Clark* [3]

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[2] Center for Analysis and Prediction of Storms

[3] NOAA National Severe Storms Laboratory

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This study will evaluate how the physics parameterization schemes available in the Weather Research and Forecasting (WRF) model version 3.1 influenced MCS development during the Spring 2010 Experiment at the NOAA Hazardous Weather Testbed in 2010, with particular attention paid to false alarm systems – those MCSs predicted to develop by ensemble members but not observed. The CAPS ensemble provided a 26 member 4-km suite of simulations using the WRF-ARW, WRF-NMM and ARPS dynamic cores. The CAPS 2010 data had six of the ARW members with differences only in the physics parameterization schemes. Three ARW members allowed for multi-scale error growth and predictability by having initial condition perturbations at various scales. Two members considered in this study did not have radar assimilation data, allowing us to identify what role radar assimilated data played in the development of false alarm MCSs. The experiment ran from 26 April to 18 June, and 4 dates were identified as having a false alarm MCS in several members. For the purpose of this study, a false alarm MCS was defined using the following: 1) convection in the model had to have a minimum length of 100 km, 2) it had to produce at least half an inch of rainfall within 3 hours 3) convection had to be sustained for a minimum of 3 hours, and 4) no convection could occur in real time within a 200 km radius of the false alarm MCS. Once found, the different ensemble members were compared to find which PBL and physic schemes contributed to false alarm MCSs in the dataset. The presentation will focus on details of the environments present when false alarm MCSs were predicted, and will attempt to isolate common features that might increase the risk of false alarms.

4B3.6 ID:5735 11:45

Ensemble Prediction for A Severe Weather Event: A Study of the 2009 Southern Ontario Storm

Geoffrey Bell , *Yongsheng Chen*

York University

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The predictability of meso-scale phenomena associated with severe weather events remains a particular challenge for current NWP models, given the highly non-linear nature of the processes involved. In order to augment the predictive power of the NWP model (WRF) used in this study to model one such event (the

August 20, 2009 storm of Southern Ontario), an ensemble approach was employed. The premise of the study presented is that an ensemble of lower resolution models could match the performance of a higher resolution model, even for such extreme weather phenomena as the storm of this study. Results which indicate a predictive ability of the ensemble comparable to the higher resolution model will be presented, along with results which indicate that the ensemble method allows for conclusions to be drawn regarding the underlying dynamics of the storm event.

Satellite data assimilation in global or regional weather prediction systems (NWP) PART 1 / Assimilation d'observations satellitaires pour les prévisions météorologiques globales ou régionales (NWP) PARTIE 1

Room / Endroit (Grand salon B), Chair / Président (Louis Garand), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B2.1 ID:5410 10:30

Assessing the benefits of assimilating cloud-affected SEVIRI radiances into ECMWF model

Cristina Lupu , *Tony Mcnally*
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This presentation will give a summary of recent progress at ECMWF in assimilation of cloud-affected SEVIRI geostationary radiances in overcast conditions, along with an outlook of future developments. Experiments with overcast SEVIRI radiances in addition to the clear-sky data set from Meteosat-9 has been run to evaluate the extent to which useful information on humidity can be derived from cloud-affected SEVIRI radiances. We will discuss recent results to characterise how these radiances affect the wind analysis via 4D-Var tracing, and compare the impact to that of the assimilation of clear-sky radiances and cloudy AMVs from SEVIRI. The overall impact of the additional overcast SEVIRI radiances on wind analyses is positive with the best results particularly over the Southern Hemisphere in the upper-troposphere. The impact of directly assimilating such data on forecast skill remains limited in the operations-like context and will be discussed. Finally, the observation influence in the assimilation process and the related contribution to the short-range forecast error of cloud-affected radiance observations from Meteosat-9 will be presented.

4B2.2 ID:5528 10:45

3DVAR assimilation of MODIS aerosol optical depth for regional air-quality analysis and prediction using WRF/Chem model

Zhiquan Liu [1], *Hui-Chuan Lin* [1], *Craig Schwartz* [1], *Quanhua Liu* [2]

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Assimilation of the MODIS aerosol optical depth (AOD) has been developed within the NCEP GSI 3DVAR data assimilation system. This newly developed algorithm allows the analysis of 3-D mass concentration of 15 GOCART aerosol variables from the WRF/Chem model. The Community Radiative Transfer Model (CRTM) was extended to serve as AOD observation operator in the GSI. The impact of MODIS AOD data assimilation was demonstrated by application to a dust storm from 17 to 24 March 2010 over East Asia. Results indicate that assimilating MODIS AOD substantially improves aerosol analyses and subsequent WRF/Chem model forecasts when compared to MODIS AOD, independent AOD observations from the ground-based AERONET and space-borne CALIOP, and surface PM10 observations.

Recent extension of the system allows simultaneous assimilation of MODIS AOD and surface PM2.5. Relative merit of assimilating MODIS AOD and surface PM2.5 was evaluated over the continental United States during the period from 02 June to 14 July 2010. Assimilating AOD, either alone or in conjunction with PM2.5 observations, produced substantially better AOD forecasts than a control experiment that did not perform DA. Additionally, the best PM2.5 forecasts were produced when both AOD and PM2.5 were assimilated. However, assimilating AOD is more efficient than assimilating PM2.5 to reduce PM2.5 forecast bias.

4B2.3 ID:5408 11:00

A hybrid WRF-3DVAR and FDDA assimilation system: Impact of AMSU-AB and MHS radiance assimilation

Yubao Liu [1], *Dorita Rostkier-Edelstein* [2], *Wei Yu* [1], *Zhiquan Liu* [1], *Craig Schwartz* [1], *Adam Pieterkowski* [3], *Scott Swerdlin* [1]
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NCAR Real–Time Four–Dimensional Data Assimilation (RTFDDA) and forecasting system is a WRF-based multi-scale 4-dimensional weather analysis and prediction system. Its ability to effectively assimilate both direct and retrieved observations available at all time and locations makes the system very capable of supporting various weather-critical applications at high-spatial resolutions. Recently, the RTFDDA system has been enhanced by the incorporation of the WRF-3DVAR component that can assimilate non-direct observations such as satellite radiances and radar radial winds. In this new hybrid system, grid-nudging is implemented to incorporate WRF-3DVAR analyses into RTFDDA. A hybrid RTFDDA-WRF3DVAR system has been implemented to provide high-resolution (3.3 km grid) weather forecasts over the Eastern Mediterranean regions. The sparse weather observation network and lack of conventional observations in the region compel the assimilation of remote-sensed non-conventional observations. In this paper, we will present the system framework and the results of numerical experiments that are designed to understand and refine the performance of the key components of the modeling system, including WRF-3DVAR specifications, 3DVAR background error-covariances optimization, radiance- (AMSU-AB and MHS) bias correction and assimilation, and grid-nudging settings. Verification against radiosondes and radar observations shows the positive impact of AMSU-AB and MHS radiances assimilation on lower tropospheric forecasts, in particular on moisture and precipitation fields.

4B2.4 ID:5303 11:15

Observing System Simulation Experiments (OSSE) to estimate the data assimilation impact of satellite winds obtained from the future Polar Communications and Weather (PCW) mission

Louis Garand , *Yves Rochon* , *Jian Feng* , *Sylvain Heilliette*
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Atmospheric motion wind vectors (AMV) are an important data type for numerical weather prediction. AMVs are winds derived from tracking clouds or water vapor features using temporal sequences (triplets) of visible or infrared imagery. Geostationary satellites produce AMVs at latitudes below 55 degrees from 15-30 min image sequences. AMVs are produced at latitudes above 70 degrees from AVHRR and MODIS imagers from sequences of about 100 min (orbital period), which is rather long. Due to difficulty in obtaining images triplets, there are essentially no AMVs in region 55-70 N/S. The Canadian Space Agency is planning to launch a constellation of two satellites in a highly elliptical orbit by 2018. The mission, called Polar Communications and Weather (PCW), will produce 15 min imagery over the entire circumpolar domain 55-90 N, thereby providing geostationary-like spatio-temporal coverage. Environment Canada has developed a data assimilation capability to conduct Observing System Simulation Experiments (OSSE). All data types currently assimilated operationally are simulated using as input a “truth” atmosphere which is a long forecast (up to one year). Similarly, future data types can be simulated. Simulated data are properly perturbed. The potential impact of PCW AMVs on top of all other data types was assessed from 2-month long assimilation cycles, with analyses produced every 6 hours. Forecasts up to 5 days, with and without PCW AMVs, can be evaluated against both the truth atmosphere and against analyses generated by the assimilation cycle. Consistency between these two results provides confidence on the realism of the OSSE. Results indicate a clear positive impact on winds, temperature and humidity, not only in the polar region, but at lower latitudes as well. The sensitivity of the impact to the assigned AMV observation error was also assessed.

4B2.5 ID:5772 11:30

Evaluation of Observing System Simulation Experiments (OSSEs) based on impact of observations on analyses and forecasts

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Observing Systems Simulation Experiments are often too optimistic regarding the impact of a future instrument. It is important to establish the impact of the synthetic observations of a proposed instrument on analysis and forecasts when they are assimilated on top of the currently available observations. To maintain consistency, the existing observations need to be synthesized from the same nature run that is used to create the measurement of a future instrument. One criterion that has been proposed is to make sure that the relative impact of the existing real observations compares to that of their synthetic equivalent when assimilated. The impact of observations is measured on the analysis by calculating the information content added by each observation type using a method developed by Lupu et al. (2010-a,b). It is also possible to use the impact of observations on forecasts to assess the relative observations of the observations following a method proposed by Gelaro and Zhu (2009). In this paper, the impact of observations from an OSSE prepared for the Polar Communication and Weather mission (Garand et al,. 2012) will be evaluated and compared to that of an experiment assimilating real observations. The impact of observations on forecasts is evaluated using the adjoint-based method of Langland and Baker (2004). The calculation is done with an algorithm that is simpler to use for any variational data assimilation system.

Planetary and Exo-Planetary Atmospheres, Surface Interactions / Atmosphères planétaire et exoplanétaires, interactions de surface et exobiologie

Room / Endroit (Grand salon C), Chair / Président (John C. McConnell), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B7.1 ID:5522 10:30

A meteoritic origin for the putative surface reservoir of organic carbon on Mars and relevance to the detection of methane in the martian atmosphere

John Moores [1], *Andrew Schuerger* [2], *Christian Clausen* [3], *Nadine Barlow* [4], *Daniel Britt* [3]

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Reanalysis of the results from the Viking Landers by Navarro-Gonzales et al in 2010 suggested detection of organic carbon in the soil at both VL1 and VL2 sites at the level of a few ppm. By using a numerical radiative transfer code for the martian atmosphere, we will show how this level of carbon can be explained if the source of the organic carbon is Interplanetary Dust Particles (IDPs) undergoing UV Photolysis.

The breakdown of IDPs by UV radiation will also produce significant quantities of methane. The amount of carbon expected to be present on the surface of Mars, if converted largely to methane, would explain the background signal of ~10ppbv reported by Mars Express. Furthermore, this methane would allow emissions from surface concentrations of organics to be tracked from orbit by a TGO-like spacecraft yeilding insights on the production and destruction mechanisms of methane on Mars and acting as a tracer to observe the circulation of the martian atmosphere.

However, the rate of accretion and conversion of IDP Organics at Mars cannot explain the large 45 ppbv plumes observed by Mumma et al (2009). Instead, limits will be presented that describe the limiting case of a sudden influx of organic carbon to the surface by an atmospheric airburst of a loosely consolidated organic-rich body.

4B7.2 ID:5391 10:45

Using airglow to understand the energetic balance in CO_2-dominated atmospheres

Marie-Ève Gagné [1], *Stephen Bougher* [2], *Amanda Brecht* [3], *Francisco Gonzalez-Galindo* [4], *Franck Lefèvre* [5], *Stella Melo* [6], *Kimberly Strong* [1]

[1] University of Toronto

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Forecast of temperature at the aerobreaking altitudes in the Martian atmosphere remains a major challenge as models and measurements differ significantly. In this altitude range, the oxygen photochemistry controls the energetic. Indeed, atomic oxygen is a major player in the CO_2 15-μm cooling mechanism in the neutral atmosphere. Accurate density profiles of atomic oxygen are required to constrain the behavior of Global Circulation Models (GCMs) above 50 km but direct measurements have not been made up to this day. Without proper validation of Mars GCMs, an underestimation of the atomic oxygen content would yield an overestimation of the temperatures because of the role of CO_2 15-μm cooling in the thermal balance.

We are investigating the possibility of deriving temperature measurements from airglow detection in the middle atmosphere of Mars. Airglow arises from the emission of energy due to photochemical reactions that occur in the atmosphere, usually at high altitudes where the atmospheric density is relatively low. Airglow measurements provide a highly promising approach for the determination of temperature over the middle atmosphere given the strong heritage of this technique for Earth observations. Airglow has been observed on Mars during the Mariner 6, 7 & 9 missions in the early 1970's; the presence of atmospheric airglow features in different spectral regions has since been confirmed by the measurements of instruments on board Mars Express and Mars Reconnaissance Orbiter.

We will describe the work regarding the simulations of airglow emissions in the Mars atmosphere and how this study can enable us to better understand: (1) the photochemical reactions that involve atomic oxygen, (2) the mechanisms that control the atomic oxygen density, and (3) the implication of the atomic oxygen concentration for the thermal structure and the energetic budget. This work has led us to the development of an airglow model to make predictions about the emission rate and distribution of the nighttime emissions of O_2 and NO in CO_2-dominated atmospheres. This model has been run using both Martian and Venusian atmospheric conditions from 3-D GCMs to provide consistency in the oxygen photochemical scheme by comparing our results with observations of these airglow emissions in both atmospheres.

4B7.3 ID:5802 11:00

The York Mars Model

Stephen Beagley , *Victor Fomichev* , *Kirill Semeniuk* , *Jacek Kaminski* , *Di Wu* , *Farahnaz Rastgar* , *Alex Lupu* , *Jack Mcconnell*
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The York Martian model is currently being re-developed and assessed to be used in a semi-operational mode as part of the MATMOS project. Using the Canadian GEM atmospheric model core a model of the Martian atmosphere has been built over the past few years as part of several Ph.D. studies. More recently this model has been re-examined and re-developed to be of use for dynamical and eventually chemical assessments of Martian atmosphere as part of the planned MATMOS satellite project in conjunction with the CSA, together with a continuing role as a research tool. New experimental work targeted for the near future includes studies on the Martian thermosphere, gravity wave impacts, dust modelling, and CO2-ice cap evolution.

4B7.4 ID:5649 11:15

Phoenix LIDAR Observations of Mars Atmospheric Dust

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The Phoenix lidar obtained measurements from the surface in the Artic region of Mars (68.22o N, 234.25o E). The lidar captured the vertical distribution of dust and clouds that drifted past the Phoenix landing site. The analysis of these measurements indicates that the planetary boundary layer (PBL) is well mixed up to a height of ~ 4 km by daytime convection and turbulence. The dust loading reached its peak around the local summer solstice, with extinction coefficient values ~ 0.1 km-1, and generally decreases as the mission progresses through Mid-summer. The total atmospheric optical depth was mostly below 0.4, although higher values (0.8) were sporadically observed around the summer solstice. Starting about 70 sols after landing, the lidar observed a regular pattern of cloud formation in the PBL and at the surface, in addition to dust. The retrieved backscatter color ratio values associated with Mid-summer dust range from 1.2 to 1.4, and their interpretation in terms of Mie theory is consistent with a dust particle size distribution with an effective radius reff between 1.2 µm and 1.5 µm.

4B7.5 ID:5608 11:30

Observations of wind direction on Mars by automated analysis of images from surface missions

Raymond Francis [1], *Moores John* [1], *Mcisaac Kenneth* [1], *Choi David* [2]
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Past missions to Mars have revealed the presence of clouds in the atmosphere, visible both from the surface and from orbit. Where atmospheric sounding instrumentation is not available, the motion of such clouds can be used as a proxy for wind observations. Such observations aid in the study of the martian climate, as well as of mass and moisture transport in the atmosphere. An understanding of the water cycle on Mars has important implications for models of the transport, distribution, and preservation of any biomarkers which might exist from past or present life on the planet.

The present work discusses the development of an algorithm for automated image analysis, the function of which is to identify clouds in sequences of images of the martian sky, and to track their movement across frames in the sequence to allow a calculation of the wind speed. The system is currently under development using imagery from previous surface missions for reference and test. Past work has used these images for manual tracking of clouds and wind estimation; the current effort aims to automate the process to allow faster and more accurate analysis. The work will be adapted for use on future missions to allow regular observations of the wind in the atmosphere near spacecraft landing sites. The image-analysis strategy to be used in the algorithm is presented, and its planned validation with existing data to test its performance in recognizing the types of clouds expected on Mars is described.

4B7.6 ID:5523 11:45

Anticipated Atmospheric Measurements of Dust and Ice from the Mars Science Laboratory Rover

John Moores [1], *Raymond Francis* [1], *Emily Mccullough* [1], *David Choi* [2]
[1]

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The Mars Science Laboratory (MSL) Rover is anticipated to land at Gale Crater (4.49 S, 137.42 E) in early August, 2012. Once on the surface, the rover will conduct environmental monitoring for at least one martian year. MSL provides an exceptional platform for atmospheric measurements with several instruments able to contribute to answering fundamental questions about the composition and dynamics of the equatorial atmosphere on Mars.

This presentation will focus on discussing some of the measurements of dust and water ice in the atmosphere that are likely to be conducted from the MSL platform over the course of the primary mission. Additionally, we will give a broad picture of the environmental monitoring that the rover is expected to conduct and the atmospheric questions we hope to address.

Ocean-atmosphere modelling and analysis / Modélisation et analyse océan-atmosphère

Room / Endroit (Symphonie 1), Chair / Président (Youyu Lu), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B5.1 ID:5685 10:30

An alternative spatial discretization of global climate models

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A 3-dimensional global ocean circulation model, named iHYCOM, is under development at NOAA's Earth System Research Laboratory. The model is destined to become the oceanic counterpart of the finite-volume, flow- following, icosahedral atmospheric model FIM (http://fim.noaa.gov). FIM uses an icosahedral horizontal grid and a hybrid-isentropic vertical coordinate.

Grid nesting is common in weather modeling, but grid discontinuities are usually kept away from the region of interest. To avoid joining disparate grids at the ocean-atmosphere interface, arguably the region of most interest in coupled modeling, HYCOM has been recoded for an icosahedral grid. The mathematical similarity of the two models allows them to share the dynamic core and software engineering innovations developed for FIM.

Preliminary results from the ocean model alone and the coupled model will be discussed. The merits of discretizing equations on structured and unstructured grids will be assessed by comparing results from iHYCOM and the standard HYCOM, both driven by CORE forcing fields. Several performance measures indicate that running HYCOM on an icosahedral mesh is feasible. This paves the way for efficient coupling to an icosahedral atmospheric model without the need for an interpolating flux coupler.

4B5.2 ID:5494 10:45

Validation and Simulation of Sea Surface Temperature at the Main Development Region for Tropical Cyclones in Eastern North Pacific Ocean using the Third Generation of the Canadian Global Climate Models

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The maximum potential intensity of tropical cyclones and its disastrous impact on socio-economic growth is directly related to the extent of the warming of sea surface temperature. Such oceanographic condition has corresponded positively with the atmospheric concentration of greenhouse gases in a coupled simulation of climate models. However, the ability of global climate models to predict future climate changes possess imbedded uncertainties extenuated by various emission scenarios of future greenhouse gas concentration. We will use the Canadian Climate Change Scenario Network to compare the performance of global climate model's performance in simulating climate variables on a thirty-year average. We will use the third generation of the Canadian Global Climate Model (CGCM3) to simulate the climate baseline of monthly sea surface temperature from 1981-2010. The monthly simulation will extend from May-November of the tropical cyclone season in the Eastern North Pacific Ocean with a spatial scale pertaining to the Main Development Region (10-20 degrees N and 85-140 degrees W), the main genesis region for tropical cyclones. Modeled sea surface temperature will be statistically compared with the observed record from the British Atmospheric Data Center. This validating exercise will provide the statistical confidence in the application of CGCM3 to project future sea surface temperature under the three greenhouse gas emission scenarios (A2, A1B and B1).

4B5.3 ID:5502 11:00

An Evaluation of the US Navy's Mesoscale Coupled Atmosphere- Ocean-Wave Prediction System

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The Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) is applied and evaluated in the coastal zone for a one month period in this study. COAMPS is a three component system designed for regional and mesoscale prediction of air-ocean-wave coupled phenomena and is comprised of an nonhydrostatic atmospheric model, an ocean circulation model (Navy Coastal Ocean Model or NCOM) and a surface ocean wave model (Simulating WAves Nearshore or SWAN). The system makes use of the community-based Earth System Modeling Framework (ESMF), which facilitates the interaction among the model components. The Navy Coupled Ocean Data Assimilation (NCODA) is used for data assimilation and initialization for NCOM and the NRL Variational Data Assimilation (NAVDAS) is used for atmospheric data assimilation. Both NCODA and NAVAS use three-dimensional variational methods for the basis of the data assimilation. While shorter duration air-ocean-wave coupled tropical cyclones case studies have been carried out in the past using COAMPS through the use of special observations, the goal of this effort is to perform and evaluate predictions over a longer time period, using conventional observations. Our focus will be on the air-wave interactions. Thus, directional wave spectra and surface meteorology observations from the National Data Buoy Center (NDBC) will be of special interest in this study and will be used to evaluate the ocean wave predictions. The system in this application is configured with three telescoping nests for the atmosphere, two for the ocean and one for the wave component, centered over the Channel Islands of the Southern California bight. The primary one- month evaluation period begins on January 15th 2010, with a

two-week spin-up. A series of 96-h forecasts are performed twice daily at 00 and 12 GMT, with hourly outputs. We will present an statistical evaluation of the near-surface atmospheric and ocean parameters and will compare these with a control experiment in which the wave component is forced by the atmosphere without providing any feedback.

4B5.4 ID:5707 11:15

Changes in weather storm events over the Hudson Bay area (Canada) in links with regional sea-ice state

Philippe Gachon [1], *Rabah Aider* [2], *Philippe Martin* [1], *Milka Radojevic* [2], *Christian Saad* [1], *Ronald Frénette* [1], *André Cotnoir* [1]
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Among the numerous storm tracks studies, no in-depth analysis has been done on the characteristics of storms over the Hudson Bay (HB) area, especially with regards to their specific links with sea-ice features. Hence, the main aim of our study is to improve our knowledge on trajectories, occurrence, frequency, duration/persistence and intensity of meteorological storms over the HB area, as well as on the risk and scale of storm surge and wave activities to come at intra- and inter-annual time scales. This is to support a vulnerability and adaptation study lead by the Ministry of Transport of Québec (MTQ) in which the HB maritime infrastructures are concerned, and ultimately to better anticipate and mitigate the impacts of climate change on this vulnerable ecosystem. The characteristics of storm are defined in terms of track density, speed of moving or duration, and cyclonic re-development over various areas of HB using different datasets from both global (NCEP and ERA-40) and regional (NARR) reanalysis, and from high resolution data series using regional climate model (RCM) outputs (three series of runs driven by both NCEP and ERA-40) over the recent decades (i.e. 1979-2007). The results of this study suggest that the storms in early winter and summer are strongly linked with sea-ice features with an increase in life cycle, and local re-development of storms with a reduction of their speed of moving when sea-ice decreases, especially in eastern part of HB and over the Hudson strait. In the context of potential reduction in sea-ice extent and duration over the coming decades (using RCM simulations over the 2041-2070 period), associated with polar amplification of global warming, certain combined effects and feedbacks between sea-ice and storms are also anticipated to be potentially exacerbated with some direct influences on the regime of oceanic waves within the HB area.

4B5.5 ID:5375 11:30

Downscaling ocean conditions: initial tests of a new method using a quasi-geostrophic ocean model

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The motivation for this work comes from the need to downscale ocean conditions. Recently Henshaw et al. (2003) provided evidence that small scale features can be reconstructed from the large scale due to the non-linearity of the Navier-Stokes equation. Methods that take advantage of this non-linear coupling across the length scales are now being used to downscale atmospheric conditions. We propose that a similar method, based on nudging in specific wavebands and frequencies, can be used to downscale ocean conditions. To investigate this proposal, we introduce a hybrid method that combines spectral nudging of the large scales and assimilation of observations to correct the small scales. The new method is applied to an idealized ocean (quasi-geostrophic) model and several twin experiments are conducted to assess the

effectiveness of the new approach. We conclude by discussing the application of the method to realistic ocean models.

4B5.6 ID:5674 11:45

Forcing Mechanisms of Ocean Temperature and Circulation Variations in the Yellow Sea

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Ocean temperature and circulation variations during 1959-2007 in the Yellow Sea (YS) are studied based on hindcast using a two-way nested global - Northwest Pacific model. Model results show that during both cooling and heating seasons, surface heat flux is the primary factor controlling the variations of temperature and heat content. Results of a sensitivity simulation, that separates the contributions of surface momentum and buoyancy forcing, support the argument that the Yellow Sea Warm Current (YSWC) is compensation to the coastal currents driven by local wind field. Variations of the YSWC and the Tsushima Warm Current show no direct relation with each other. Both the warm water and the YSWC in winter are forced by variations in the East Asian Winter Monsoon (EAWM); but the former and later are primarily forced by changes in surface heat flux and wind stress, respectively.

Biomass Burning Smoke Plumes: Atmospheric Impacts, Detection, and Prediction / Panaches de fumée issue de la combustion de la biomasse: impacts sur l'atmosphère, détection et prévision

Room / Endroit (Symphonie 2), Chair / Président (David Waugh), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B8.1 ID:5516 INVITED/INVITÉ 10:30

Receptor modelling of surface atmospheric particulate matter in support of aircraft measurements of Boreal forest fire smoke outflow over Eastern Canada during the summer of 2011.

Mark Gibson [1], *James Kuchta* [1], *Lucy Chisholm* [2], *Tom Duck* [3], *Richard Leaitch* [4], *Jason Hopper* [3], *Stephen Beauchamp* [2], *David Waugh* [2], *Gavin King* [1], *Jeffrey Pierce* [3], *David Oram* [5], *Paul Palmer* [6]
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The BORTAS aircraft campaign, based out of Halifax Nova Scotia during summer 2011, was designed to test understanding of the chemical aging of boreal biomass burning plumes as they travel across Canada towards the Atlantic. This international study was led by the University of Edinburgh in collaboration with researchers from North America and Europe. The integrative BORTAS measurement campaign included aircraft, satellite and ground based measurements of gases and atmospheric particulate matter (PM). The aim of the ground-based measurements was to support aircraft observations, to validate forecasts of, and to apportion, the impact of forest fire plumes on surface PM in Halifax. Sampling was conducted on the roof of the Physics and Atmospheric Science Building at Dalhousie University in Halifax. The gases measured included O3 and CO. PM measurements included continuous PM10, PM2.5 and PM1.0 mass concentrations. The PM components that were measured continuously included black carbon (BC), organic carbon (OC), NH4, Cl, NO3, SO4. Daily filter samples were collected for the determination of fine (PM2.5) and coarse (PM2.5-10) particulate mass, cations, anions, elements and woodsmoke chemical markers. Excellent agreement (R2=0.88) between continuous and filter based measurements was observed with a gradient of 2.76. Median (min:max) fine and coarse PM mass concentrations were found to be 3.9 (0.08:13.7) and 8.5 (0.6:24.9) µg/m3 respectively. Median (min:max) continuous BC = 0.27 (0.009:3.20); SO4 = 0.10 (0:2.0); NO3 = 0.033 (0:0.45); OC = 0.80 (0:14.6); NH4 = 0.054 (0:0.79); Cl = 0.002 (0:0.09) µg/m3 respectively. The source apportionment of biomass and non-biomass smoke to surface PM in Halifax will be conducted using EPA Positive Matrix Factorization v3.0 and Chemical Mass Balance v8.2 receptor models. Receptor modelling will be conducted on the combined filter and continuous PM chemistry to inform the source apportionment of biomass and non-biomass smoke to surface PM concentrations in Halifax.

4B8.2 ID:5827 11:00

Production and Transport of Ozone From Boreal Forest Fires

Jane Liu [1], *David Tarasick* [2], *Christopher Sioris* [3], *Xiong Liu* [4], *Huixia He* [2], *Omid Najafabadi* [2], *Mark Parrington* [5], *Paul Palmer* [5], *Kevin Strawbridge* [2], *Tom Duck* [6]
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In 2010 summer, 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. Nearly 100 ozone soundings were made at 13 stations through the BORTAS Intensive Sounding Network, though aircraft measurements were all 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 fire, large amount of CO (carbon monoxide) is observed in 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, from OMI satellite data. These chemical conditions combined with sunny weather all favour of ozone

production.

On the days with large fire activities and following days, layers of elevated ozone mixing ratios over 100 ppbv are observed around 3-5 km at nearby stations (e.g., Edmonton station) or stations in distance (e. g., Egbert station). Back-trajectories suggest the elevated ozone in the profile is traceable to the fires in Saskatchewan.

4B8.3 ID:5519 11:15

Remote sensing of trace gases and aerosols in biomass burning plumes over Eastern Canada during the BORTAS field experiment

Jonathan Franklin [1], *Jeff Pierce* [1], *Lucy Chisholm* [2], *Tom Duck* [1], *James Drummond* [1], *Glen Lesins* [1], *Jason Hopper* [1], *David Waugh* [2], *Norm O'Neill* [3], *Debora Doeringer* [4], *Kaley Walker* [4]
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Biomass burning is a significant source of carbonaceous aerosols and trace gases to the atmosphere. During the summer of 2011 an international effort, led by the University of Edinburgh, aimed to evaluate the chemistry and dynamics of Boreal forest fire smoke through aircraft, satellite, and ground-based measurements. The Dalhousie Ground Station (DGS), located in Halifax, Nova Scotia, was organized to provide ground support to the BORTAS campaign. In addition to the many in-situ gas and aerosol sensors, the DGS provided multiple remote sensing measurements of both particulates and trace gases.

On 20 July, 2011, a plume of elevated CO visible in the AIRS satellite images reached the DGS and was clearly detected by two Fourier Transform Spectrometers making solar absorption measurements. FLEXPART trajectory analysis suggests that this CO plume likely originated in fires in Ontario. However, particulate data gathered from a co- located sun photometer and the Dalhousie Raman Lidar system show very low amounts of fine-mode aerosol for the initial 7 hours of the event. Particulates were seen to begin increasing in abundance towards sunset and a star photometer enabled measurements to continue after nightfall. A peak aerosol optical depth of 2.3 was measured at 0130 (UTC) on 21 July. Despite partly-cloudy conditions, the region of high trace gas, yet low particulate matter, is visible in both the AIRS and MODIS satellite images.

We will present an overview of the event from multiple points of view and discuss possible mechanisms for the aerosol/trace gas anomaly, including precipitation as the aerosol removal mechanism for the initially detected portion of the plume.

Support for this project is provided by the Canadian Space Agency (CSA) and NSERC.

4B8.4 ID:5533 11:30

Forecasting and in situ sampling of boreal biomass burning plumes over Maritime Canada during summer 2011: Flight planning and the first results from the BORTAS aircraft measurement campaign.

Mark Parrington [1], *David Waugh* [2], *Paul Palmer* [1], *Steven Pawson* [3], *Michel Bourqui* [4], *David Tarasick* [5], *Huixia He* [5], *Edward Hyer* [6], *Tom Duck* [7], *Kimiko Sakamoto* [7], *Jonathan Franklin* [7], *David Oram* [8]
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During July 2011 the UK BAe-146 research aircraft was based at Halifax NS to make detailed in situ chemical composition measurements of boreal biomass burning plumes as part of the UK-Canadian BORTAS project (http://www.geos.ed.ac.uk/research/eochem/bortas/). The primary objective of BORTAS is to quantify the impact of boreal biomass burning on tropospheric oxidant chemistry over the North Atlantic. The aircraft measurements were supported by ozonesondes launched from five locations across eastern Canada and lidar and other ground-based measurements made from Dalhousie University. Deployment of the aircraft during the campaign was informed by forecast outputs from the NASA Goddard Earth Observing System version 5 (GEOS-5) AGCM. Forecasts of carbon monoxide (CO) tagged for emissions from biomass burning (boreal and non-boreal) and fossil fuel (Asian, European, and North American) sources were produced by GEOS-5 with a horizontal resolution of 0.5 degree latitude by 0.67 degree longitude and time resolution of 3 hours. The CO forecasts were used in conjunction with forecast forward trajectories, calculated with the FLEXPART and LAGRANTO particle dispersion models driven by forecast meteorology from the Environment Canada Global Environmental Multiscale (GEM) model and initialized with near real-time fire observations provided by the Fire Location And Modeling of Burning Emissions (FLAMBE) inventory, to determine the location and transport of boreal biomass burning outflow. GEM-MACH15 output was used to determine potential anthropogenic plume interference. We present an evaluation of forecast model skill to identify and predict the location of plumes from boreal biomass burning activity, and measurements of these plumes with the aircraft. We will show that the forecasts provided reliable predictions of the location, altitude, and timing of boreal biomass burning outflow. The measurements showed significant enhancements of species associated with biomass burning (e.g. CO, ethane and aerosol backscatter over Halifax; CO, acetonitrile, and other organic compounds from the aircraft) within the plumes.

4B8.5 ID:5422 11:45

Measurements of trace gas emissions from biomass burning events at PEARL, Eureka, Nunavut, Canada, from 2007 to 2011

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Viatte, C., Lindenmaier, R., Strong, K., O'Neill, N.T and Saha, A.

We present vertically integrated column concentrations of CO, HCN, C2H6, C2H2 and C2H4 measured in the Canadian high Arctic at the Polar Environment Atmospheric Research Laboratory (PEARL) from 2007 to 2011. These measurements are made using ground-based Fourier transform infrared (FTIR) solar absorption spectroscopy, with retrievals optimized within the framework of the Network for the Detection of Atmospheric Composition Change (NDACC) Infrared Working Group harmonization effort. The trace gas columns show periodic enhancements due to the transport of smoke plumes from biomass burning events. Identification of such events is made by selecting trace gas columns for which these enhancements are correlated with simultaneous and co-located measurements of the (500 nm) fine mode component of the aerosol optical depth (AOD) from AERONET/AEROCAN CIMEL sunphotometers. These columnar aerosol mesurements are supplemented when possible by backscatter lidar measurements from the AHSRL (Artic

High Spectral Resolution Lidar) of the University of Wisconsin and the CRL (Candac Raman Lidar) of Dalhousie University. To verify boreal forest fire events and track the paths of the plumes back to their sources, MODIS images, MOPITT CO data, and the back- trajectory model HYSPLIT are used. Because the composition of smoke plumes can vary rapidly with time, columns are converted into emission ratios relative to CO or to AOD as a CO proxy, and then into emission factors.

Regional Climate Modelling and Climate Projections PART 7 / Modélisation du climat régional et projections du climat PARTIE 7

Room / Endroit (Symphonie 3A), Chair / Président (Anne Frigon), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B6.1 ID:5582 10:30

Radiative impacts of the representation of sub-grid scale cloud variability using a modified Monte Carlo Independent Column Approximation (McICA) methodology in the Canadian Regional Climate model (CRCM5)

Danahé Paquin-Ricard [1], *Paul A. Vaillancourt* [2], *Jason N. S. Cole* [3], *Howard W. Barker* [3]

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Climate models often use tuning parameters in order to correct homogeneous cloud radiative biases even if it leads to compensating biases and simulated clouds or precipitation that disagree with observations. The Monte Carlo Independent Column Approximation (McICA) and its stochastic cloud generator (SCG) were created to address this issue by replacing fixed and biased hypotheses with flexible and unbiased cloud fraction overlap and cloud water horizontal variability assumptions. This method is currently used in several climate and numerical weather prediction (NWP) models.

For the CRCM5 (based on the Global Environmental Multi-scale model), the McICA method and the SCG have been implemented with a first-order differentiation between the three cloud types produced by the model: stratiform; deep; and shallow convective clouds. This allows the use of different SCG parameters for vertical overlap and horizontal variability as a function of cloud type.

First, the SCG was altered to account for three simultaneously occurring cloud types. Second, surface and satellite observations were used at high spatiotemporal resolution to derive the SCG parameters for the three cloud types. Third, CRCM5 was outfit with the new SCG and McICA and results were compared to observation datasets, again from surface and satellite instruments.

This presentation will focus on the comparison between the modeled radiative fluxes at surface and top-of-atmosphere and observations from ARM surface sites and satellites. The different parameters of the SCG will be compared based on their radiative impacts.

4B6.2 ID:5455 10:45

Analysis of Change in the Great Lakes Net Basin Supply using Regional Climate Simulations

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The majority of hydrological impact assessment studies for the Great Lakes are based on traditional hydrological models, where climate variables are perturbed by the CC signal derived from transient GCM simulations. This technique does not allow exchange of energy and water between land surface and atmosphere, and therefore does not capture important feedback processes occurring between the two components. Several recent studies suggest that the hydrological models, which typically use air temperature as a proxy for potential evapotranspiration across all time scales and climate regimes, project an exaggerated evapotranspiration increase in future climate due to global warming. As a consequence, significant runoff reduction in the Great Lakes Basin is projected, resulting in decreased net basin supply (NBS) and a drop in Great Lakes water levels.

In this study, we analyze an ensemble of transient Regional Climate Model (RCM) simulations to assess the range of possible changes in the Great Lakes' NBS. Given the fact that surface energy budget constraints in traditional hydrological models are not necessarily enforced, the NBS projections obtained from direct hydrological outputs of RCMs, which are designed to conserve mass, energy and moisture, should be more reliable. In addition, throughout a RCM simulation, exchanges of water, energy and momentum fluxes take place across the soil-vegetation-atmosphere interface at each time step, thus allowing the effects of important feedback processes to be included.

4B6.3 ID:5508 11:00

The role of bias correction of regional climate scenarios for use in hydrological model applications.

Blaise Gauvin St-Denis [1], *Markus Muerth* [2], *Simon Ricard* [3], *Juan Alberto Velázquez* [4], *Seppo Schmid* [2], *Diane Chaumont* [1]
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Regional climate models often show biases with respect to observations and when this data is used as input to an impact model, it becomes difficult to reproduce observed conditions. One solution is to apply simple bias correction methods on the regional climate model data. Even so, when using an impact model in both the recent past and future in order to compute a climate change signal, it is not immediately clear whether using this bias corrected data provides a significantly different answer than using biased data. Hence it is relevant to ask if bias correction really provides added value in evaluating climate change signals. In the QBic³ project (Québec-Bavaria International Collaboration on Climate Change), data from multiple regional climate models, driven by multiple global climate models is used as input to four hydrological models over two natural-flow sub-catchments. A comparison of many hydrological indicators obtained with and without the use of bias correction of the regional climate data is then carried out. As expected, the use of bias correction allows a better reproduction of the hydrological conditions of the recent past. However, for most

indicators, the ensemble of climate change signals is weakly affected by bias correction, except for the timing of the spring flood peak. Also, one particular climate simulation with the largest biases shows a significant sensitivity to bias correction. It becomes apparent that with a fairly large ensemble of climate simulations and hydrological models, the uncertainty associated with those components is greater than that introduced by whether or not bias correction is used. Nevertheless, if only few climate simulations are available, bias correction should be considered. In the end, a good understanding of model biases and their potential consequences with respect to the impact model should not be bypassed.

4B6.4 ID:5630 11:15

Uncertainty of empirical downscaling in quantifying the climate change impacts on hydrology over two North America river basins

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Climate dynamical models at the global and regional scales are widely used to assess the impact of climate change. However, the resolution of climate models is too coarse to properly assess the impacts at the fine scale such as needed for small watershed hydrology and field agriculture research. Additionally, model outputs (usually precipitation and temperature) needed to perform such studies suffer from various biases. To overcome the scale and biases problems, various statistical and dynamical downscaling techniques have been developed. Amongst the various statistical approaches, empirical downscaling methods are very commonly used due to the ease of their implementation. Empirical downscaling is a Model Output Statistics (MOS) approach that seeks to use information from biased model fields. Empirical downscaling has shown to give results similar to that from more complicated downscaling approaches. Several empirical downscaling approaches have been proposed and it is necessary to assess to which extent the choice of one versus the other contributes (or not) to the overall climate change uncertainty. This work assesses the uncertainty of six empirical methods in downscaling Regional Climate Models (RCMs)-projected precipitation and temperature. These downscaling methods are further investigated in quantifying the hydrological impact of climate change over two North America river basins under different climate conditions (Manicouagan 5 basin in Quebec, and Chickasawhay basin in Mississippi). The six empirical downscaling methods are grouped into change factor (two methods) and bias correction approaches (four methods). The uncertainty obtained from the choice of an empirical downscaling method is compared to that associated with the choice of a climate projection, through the use of four different RCMs. Downscaled future (2041-2065) climate projections are first compared to the reference period (1971-1995). Then, future hydrological regimes simulated with an empirical lumped hydrology model are then compared to the reference period using six different hydrology criteria. All six downscaling methods suggest increases in temperature for both river basins. The precipitation is likely to increase, especially for the Manicouagan 5 basin. The uncertainty related to empirical downscaling was small in predicting annual and seasonal precipitation and temperature. It was also small with respect to precipitation and temperature extreme events. The uncertainty linked to the choice of an empirical method was not sensitive to the choice of a given RCM. The RCMs-related uncertainty was consistently larger than the uncertainty related to the empirical downscaling methods. With respect to the hydrology, all six downscaling methods and four RCMs suggest increases in annual and winter discharge for the Manicouagan 5 basin, and possible decreases over the summer. The mean discharge will be likely to decrease for the Chickasawhay basin. The uncertainty due to empirical downscaling was not found to be important in predicting mean streamflow statistics such as annual and seasonal mean discharges. On the other hand, it was important for extreme statistics such as summer and winter extreme flood for the Manicouagan 5 basin and dry and wet seasons flood for the Chickasawhay basin. The uncertainty linked to the choice of an empirical downscaling approach (change factor vs. bias correction) was much larger than within each group. Comparing the uncertainty envelope of empirical

downscaling methods to the one resulting from climate projections indicates that the former is much smaller and may largely be considered insignificant for mean streamflow statistics. However, both of them are comparable for some of the extreme statistics, such as the summer extreme flood for the Manicouagan 5 basin.

4B6.5 ID:5540 11:30

A new statistical-dynamical downscaling technique for regional time series generation. Wind resource estimation

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A new statistical-dynamical downscaling procedure is developed and then applied to high-resolution (regional) time series generation and wind resource assessment. The statistical module of the new procedure uses Empirical Orthogonal Functions (EOFs) analysis for the generation of large-scale atmospheric component patterns. The dominant atmospheric patterns (associated with the EOF modes explaining most of the statistical variance) are then dynamically downscaled or adjusted to high-resolution terrain and surface roughness by using the Global Environmental Multiscale - Limited Area Model (GEM-LAM) model. Regional time series are constructed using the model outputs. The new method is applied to the Gaspe region of Quebec in Canada. The dataset used is the National Centers for Environmental Prediction (NCAR/NCEP) Reanalysis of wind, temperature, humidity and geopotential height during the period 1958-2004. Regional time series of wind speed and temperature are constructed and a numerical wind atlas of the Gaspe region is generated. The generated time series and the numerical wind atlas are compared with observations at different masts located in the Gaspe peninsula and also compared with a numerical wind atlas for the same region generated in Yu et al. (2006). Our results suggest that the newly developed procedure can be useful to generate regional time series and reasonably accurate numerical wind atlases using large-scale data with much less computational effort than previous technique.

4B6.6 ID:5315 11:45

Statistical Downscaling of Sea Surface Winds over the Global Oceans

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The statistical prediction of sea surface winds over the global oceans is investigated using a downscaling model based on multiple linear regression. The predictands (mean and standard deviation of both vector wind components and wind speed) calculated from ocean buoy observations on daily, weekly and monthly temporal scales are regressed on free-tropospheric predictor fields (zonal wind, meridional wind, wind speed, and air temperature) from reanalysis products. It is found that in general the mean vector wind components are more predictable than mean wind speed in the North Pacific and Atlantic, while in the tropical Pacific and Atlantic there is no substantial differences in predictive skill between mean vector wind components and wind speed. The relative predictability of wind speed to the statistics of vector wind components is interpreted by an idealized Gaussian model of wind speed probability distribution. This model characterises the sensitivity of wind speed to standard deviations and means of vector wind components and the variability of these wind statistics with season, geographic location and averaging timescale .

Science Support of Air Quality Management / La science au service de la gestion de la qualité de l'air

Room / Endroit (Symphonie 3B), Chair / Président (Robert Nissen), Date (01/06/2012), Time / Heure (10:30 - 12:00)

4B4.1 ID:5658 10:30

Modelling Support for Canadian Air Quality Regulation and Policy

Sophie Cousineau , *Gilles Morneau* , *Didier Davignon* , *Jack Chen* , *Annie Duhamel* , *Mehrez Samaali* , *Mourad Sassi* , *Jacinthe Racine*
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The REQA unit (unité de Réponse aux Enjeux de Qualité de l'Air), within the Air Quality Modeling and Application Section (AQMAS) of Environment Canada, is responsible for providing regulatory guidance to policy-makers on air quality. The REQA team is involved in many science and policy development studies both nationally and internationally. In order to provide such guidance, air-quality model scenarios analysis are the most common means used to estimate the impact of emission changes on atmospheric pollutant concentrations. This presentation will give an overview of the methodologies used in air quality emission scenario analysis, the REQA modelling platform used to create baselines and projected scenarios as well as an overview of past realizations and current projects.

4B4.2 ID:5541 11:00

Trends relative to the use of prognostic models for air quality assessments

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Historically, the MM5 meteorological model has been used by the air quality modelling community. This model, however, has been officially phased out by the National Center for Atmospheric Research (NCAR). Specifically, NCAR (2008) announced on October 31, 2008 that technical support for the MM5 model has been discontinued and strongly encouraged users to move to the new NCAR supported WRF model. WRF provides better algorithms, handling of topography, and programming than MM5; and includes new features and options developed by the Mesoscale & Microscale Meteorology Division at NCAR. Many studies have demonstrated that WRF has met the requirements for transition from MM5, and outperforms MM5 in overall model accuracy (U.S. EPA 2010).

Considering the advantages associated with the new generation WRF model, we foresee this model being used more and more for future air quality assessments. This presentation focuses on the application of the WRF model to produce 5-years (2002 to 2006) of meteorological data at a 4 km resolution over a nominal 300 by 700 km domain in northeastern Alberta. The National Center for Environmental Prediction (NCEP) 32 km resolution North American Regional Reanalysis (NARR) data were used as input to Version 3 of the WRF model. The 5-year, 4 km grid WRF model output was used as input to the CALMET/CALPUFF model system. The CALMET/CALMET system was then used for an air quality assessment for an oil sands project regulatory application that was part of a multidisciplinary Environmental Impact Assessment. The

presentation also provides an overview of the WRF model performance of a few select parameters including precipitation, surface winds and temperature.

4B4.3 ID:5284 11:15

A retrospective analysis of ozone formation in the Lower Fraser Valley, B.C.

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We conduct a retrospective study of ozone formation in the Lower Fraser Valley (LFV), using numerical models, observations and emission inventories in order to understand relationships between the well-documented reduction in both local precursor emissions and spatio-temporal changes in episodic ozone concentrations. We take into account that: there is little or no impact from precursor emissions upwind of the LFV during ozone episodes; background concentrations of ozone and its precursors are generally from the North Pacific and are quite low; there has been an observed shift in the population patterns within the valley over the last 25 years and there has been a small but documented change in the tropospheric background concentration of ozone. An unintended natural experiment has taken place within the region and we use the observed changing ozone concentration- precursor emission relationship to perform a dynamical model evaluation and to study underlying precursor-ozone relations. We model ozone formation for four episodes, which both capture the observed changes in ozone reduction and the different meteorological regimes that occur during LFV ozone events, using the WRF-SMOKE-CMAQ modeling system with the SMOKE emission inventory adjusted to account for temporal changes in both amount of emissions and locations of emission sources. Model output was compared against observations, data collected from field campaigns, and previous modeling efforts. It was found that the WRF-SMOKE-CMAQ modeling framework was able to capture the changes in both the magnitude of ozone concentrations and its spatial behaviour over the 20 year retrospective period. A mechanistic exploration of changing ozone formation over the 20 year (1985-2005) retrospective period was performed using the ecaluated modelling system. For each episode, two simulations, intended to isolate the effects of emission changes from meteorological changes, were performed: one with 1985 level emissions and the other with 2005 level emissions. Based on analysis of the modeling, observational data and precursor emission inventories, we find the western Port Moody station has been and remains a VOC-sensitive location; the central part of the LFV around the town of Chilliwack has generally gone from being VOC-limited to NOx-limited; and that the eastern most part of the valley around the town of Hope has been and remains a NOx-limited region. Furthermore, based on the observational data and numerical modeling, the ozone production efficiency as a function of NO has increased noticeably at Chilliwack and likely in the other eastern parts of the valley. This efficiency increase has likely offset some of the benefits resulting from local NOx emission reductions.

4B4.4 ID:5734 11:30

Sensitivity of air quality simulations in the Lower Fraser Valley of British Columbia to model parameterizations and emission sources

Robert Nissen , *Paul Makar* , *Andrew Teakles* , *Junhua Zhang* , *Qiong Zheng* , *Michael Moran* , *Harry Yau*
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The Environment Canada Inter-comparison CMAQ-AURAMS Project (ICAP) compared the capabilities of the Community Multiscale Air Quality (CMAQ) and A Unified Regional Air-quality Modelling System (AURAMS) air quality models for a domain covering the Lower Fraser Valley and the complex terrain of

coastal British Columbia. Both models were driven by meteorology provided by the Canadian Global Environmental Multiscale (GEM) model, and were run on a polar stereographic grid with 12-km resolution. Verification of the model outputs with surface observations of ozone and PM2.5 revealed a wide range in model performance for different locations. The study found that the choice of model parameterizations had a significant impact on the simulation results and accuracy, and that errors in some of these parameterizations compensated for other errors, in particular in the model inputs (emissions). In this presentation the impact of primary particulate matter emissions on the resulting model PM2.5 concentrations will be examined by means of a statistical analysis that shows the contrast in model performance between urban/rural and coastal/valley environments. Temporal allocation of emissions is shown to have a significant impact on model results, particularly at night, when primary PM2.5 emissions dominate the PM2.5 mass budget. The impact of various improvements to the emissions will be examined through statistical comparisons to observations.

Risk Communication and Meteorology: Interdisciplinary strategies and approaches to mitigate impacts / Communication des risques et météorologie : stratégies et méthodes interdisciplinaires pour atténuer les impacts

Room / Endroit (Grand salon A), Chair / Président (Rebecca Wagner), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C4.1 ID:5306 14:00

Communicating Risk: A Vigilance Map Project

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The vigilance concept aims to link meteorological warnings with potential impacts. This is achieved by communicating risk to groups ranging from emergency management organizations to the general public.

From January through April the Ontario and Quebec weather offices worked together to manage a parallel desk in each office that issued colour-coded warnings based on potential impacts. Multiple partners were engaged to evaluate the usefulness of these warnings which were displayed on a vigilance map. These partners included certain Ontario Provincial Police communication centres, the ministry of transportation, civil security as well as some members of the media. The vigilance map for this trial extended from Sault-Ste-Marie eastward to include all of southern and eastern Ontario, as well a large area of Quebec. Throughout the trial forecasters issued warnings based on potential impacts for a period of five days. The warnings were displayed on a web-based prototype with a Google-map background. Forecasters selected the warning zones by drawing polygons directly on the website and complemented the image with a free format text. Partners were notified of a warning via an email issued directly from the website. After an event feedback was solicited from these partners to determine if the vigilance warnings were useful and added value beyond the current national Environment Canada warnings.

This presentation will focus on lessons learned from this trial in terms of risk communication as well as future requirements should the vigilance concept become part of the national warning system.

4C4.2 ID:5732 14:15

High wind advisories for Canadian motorists: Two applications where AMEC has implemented public wind advisory systems based on location-specific thresholds

Elizabeth Loder [1], *Shawn Allan* [2]
[1] AMEC
[2] AMECHigh wind advisories for Canadian motorists: Two applications where AMEC has implemented public
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On the Seal Island Bridge in Cape Breton, Nova Scotia, motorists often encounter high winds. Trucks have occasionally been blown over on the bridge by powerful wind gusts that had not been expected or forecasted. Without weather stations nearby, motorists had no warning that high winds were imminent. To mitigate this hazard, AMEC, in cooperation with NS Transportation Infrastructure Renewal, developed a system that would monitor and broadcast wind advisories on the bridge in real-time, indicating if it was safe to cross the bridge.

AMEC installed a wind monitoring intelligent transportation system on the Seal Island Bridge consisting of a master controller monitoring wind speed and direction at the center of the arch with two slave controllers to monitor wind speed at each of end of the bridge. AMEC developed an algorithm that triggers warnings when winds exceed certain thresholds. The first threshold applies to high sided vehicles such as trucks and recreational vehicles, and a second threshold has been established for all vehicular traffic. The warnings also are linked directly into Nova Scotia's 511 public notification system and are broadcast to travelers.

In Newfoundland's infamous Wreckhouse region, AMEC installed a separate wind advisory system that uses variable message signs to advise motorists when winds are dangerously high. This project was commissioned by the Newfoundland and Labrador Department of Transportation and Public Works to improve public safety along the Trans Canada Highway in Southwestern NL. The Wreckhouse area has a reputation for its high winds, and Environment Canada has been monitoring this area for decades. Environment Canada also created the unique category of Wreckhouse Warning to indicate when conditions are favourable for high winds in this particular area. The Seal Island Bridge case in Nova Scotia is a stark contrast because until the recent interest in a wind advisory system, very little was published about the area's devastating winds. There were no weather stations around Seal Island bridge before these sensors were installed, so there is no historical record of how windy it has been and to what geographical extent this phenomenon extends.

This talk will discuss experience with both of these systems, including lessons learned and how the public might be better served through forecasting and monitoring such unique local phenomena.

4C4.3 ID:5484 14:30

Canadian Lightning Risk Display

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The Meteorological Service of Canada is developing a new risk-based lightning display. The maps and call to action statements in the display will support Canadians in making appropriate personal safety decisions based on the near term risk of lightning. Rather than displaying actual lightning strikes, lightning risk areas will be identified based on the past 20 minutes of lightning activity. The design of the risk areas will reflect and be consistent with current lightning safety messaging.

4C4.4 ID:5535 14:45

Urban heat islands and mortality: how to estimate and prevent the risks?

Karine Laaidi [1], *Abdelkrim Zeghnoun* [1], *Bénédicte Dousset* [2], *Philippe Bretin* [1], *Stéphanie Vandentorren* [1], *Emmanuel Giraudet* [3]

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Climate change is increasing the occurrence and frequency of heatwaves. Those are particularly deadly in cities where their growing elderly population is the most vulnerable. In this context we studied the risk factors of death among the elderly during the heatwave of 1-13 August 2003 in Paris and close suburbs. The study is based on joint health and climate data sets: a case-control involving 241 cases aged 65 and over, who lived at home and died during the heatwave, and 241 controls; and surface temperature recorded from Landsat and NOAA-AVHRR satellites. Those data, along with human and environmental parameters, were integrated into a conditional regression model. The satellite images showed an urban heat island (UHI) centered in Paris at nighttime, and hot spots scattered in industrial suburbs during the day. The risk of death was multiplied by 3.5 to 9.6 for former manual workers, people with lack of mobility, those sleeping in a room just under the roof, or suffering of neurological, cardiovascular or psychiatric pathologies. However, adapted behavior decreased the risk of death by 3 to 5. The temperature from Landsat, and minimum temperature from NOAA-AVHRR averaged during the whole heatwave and during the day of death and six preceding days, were significantly associated with a risk of death multiplied by 2.17 to 2.98 for the most exposed people. The study highlights the urban temperature variability and associated risk of exposure, and the role of high night-time temperature and duration of heat on mortality. Prevention measures can reduce those risks: at short-term by cooling the rooms, assisting vulnerable people and broadcasting advice; and at long-term in increasing building's insulation and surface high reflectance and vegetation. Our results should help urban decision makers to integrate public health considerations in the policies set up to mitigate the UHI.

4C4.5 ID:5307 15:00

Estimation and Value of Ambiguity in Ensemble Forecasts

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Ambiguity is uncertainty in the prediction of forecast uncertainty associated with random error in a forecast probability density function (PDF) generated by an ensemble. In ensemble forecasting, ambiguity arises from finite sampling and deficient simulation of the various sources of forecast uncertainty. This study introduces two practical methods to estimate ambiguity and demonstrates them on 5-day, 2-m temperature forecasts from the Japanese Meteorological Agency Ensemble Prediction System. The first method uses the error characteristics of the calibrated ensemble to predict likely errors in forecast probability. The second

method applies bootstrap resampling to produce multiple likely values of forecast probability. Both methods include forecast calibration since ambiguity results from random and not systematic errors, which must be removed to reveal the ambiguity. Two possible approaches for applying ambiguity information are then explored. The first approach, called uncertainty folding, merges ambiguity with forecast uncertainty information for subsequent use in standard risk-analysis decision making. Uncertainty folding is found to be of no practical benefit when tested in a low-order, weather forecast simulation. The second approach, called ulterior motives, attempts to use ambiguity information to aid secondary decision factors not considered in the standard risk analysis, while simultaneously maintaining the primary value associated with the probabilistic forecasts. Following ulterior motives, the practical utility of ambiguity information is demonstrated on real-world ensemble forecasts used to support decisions concerning preparation for freezing temperatures paired with a secondary desire for reduction in repeat false alarms. Sample products for communicating ambiguity to the user are also presented.

4C4.6 ID:5589 15:15

The Importance of Embedded Meteorologists: The Spring 2011 flood in the Richelieu (QC)

Claude Masse , *Jacques Descurieux*
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Since January 2008, MSC (Meteorological Service of Canada) of EC (Environment Canada) has developed a very close working with the COG (Centre des opérations gouvernementales) of Sécurité Civile du Québec (Public Safety). When the weather has or may have an impact on the COG operations, meteorologists are dispatched to support the day to day decision making by COG team. This approach is very valuable. Both organizations have learned to move from a one way dissemination of weather or forecast information to a real dialogical exchange: a participatory conversation where both organizations is transform information into a knowledge exchange.

In the case of the 2011 Richelieu spring flooding, this close working relationship have proven to be effective where a meteorologist was working the St-Jean sur le Richelieu coordination for about a month. Public Safety Quebec was able to use the early notification of weather information to manage all the terrain activities based on a dialogue and the knowledge sharing. Embedded meteorologist were directly involved in the decision making process. The experience of the spring floods in the Richelieu region demonstrates the value in use for all level of government of embedded meteorological leading to a better decision making process resting on knowledge exchange. It also lead to a better understanding of the uncertainty associated with meteorological forecast by MSC’s stakeholders while MSC gained a better understanding of the impacts associated with major floods.

Satellite data assimilation in global or regional weather prediction systems (NWP) PART 2 / Assimilation d'observations satellitaires pour les

prévisions météorologiques globales ou régionales (NWP) PARTIE 2

Room / Endroit (Grand salon B), Chair / Président (Louis Garand), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C2.1 ID:5664 14:00

The added value of data traceability in a Numerical Weather Prediction context: case study with GPS radio occultation

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Numerical Weather Prediction requires data geographically well distributed, with diverse kinds of measurements (temperature, moisture, mass, winds), and including data both horizontally and vertically well resolved. With GPS Radio Occultation (GPSRO) profiles, another feature became particularly relevant for the extraction of an optimal benefit: traceability, or the importance of trusting that at least a fraction of the assimilated data has a good absolute calibration. It also underscored an issue to be addressed: the level of compatibility between data that are being trusted as well calibrated. Although no data source is perfect, some technologies are known to be particularly prone to systematic inaccuracies. GPSRO emerged with, among other features, the promise of a robust technology against instrument response bias and drift. Indeed, it is based on phase measurements of electromagnetic signals, whereas most other remote sensing technologies are based on amplitude measurements (intensity or brightness temperature). A large fraction of other available data are assumed to require a calibration before being assimilated, and the model itself has only a moderate restoring tendency to remain within climatic bounds. For both reasons, it is necessary to provide absolutely calibrated measurements, which will act as anchors, to avoid analyses to develop long-period drifts, a role notably played by radiosondes and aircraft data. More recently, radio occultation profiles have been added to this subset. GPSRO became operational at Environment Canada in 2009, and after that implementation, one of the main lines of research around these data has been the improvement and exploitation of their robustness and value as anchor data. We will show indications that suggest that absolute calibration, and in particular that of GPSRO data, has a value in terms of forecast quality, on top of the value that a measurement that required bias correction would have.

4C2.2 ID:5647 14:15

Exploration of the impact of atmospheric horizontal gradients in the interpretation of occultation observations.

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Presently, local spherical symmetry of the atmosphere is assumed in most practical implementations of observation operators for GPS radio occultation (GPSRO) data, destined to Numerical Weather Prediction (NWP) applications. Concerning the limb-looking geometry of GPSRO measurements, certain refinements are possible that may improve their interpretation, in order to better validate other instruments' data, or for a more accurate data assimilation. The impact of the presence of horizontal refractivity gradients in the atmosphere has been investigated. We found that the interpretation of GPSRO measurements is sensitive to them. Magnitude and variability of this sensitivity will be presented. We have performed a preliminary exploration of practical approaches to handle this sensitivity with respect to local gradients. Spherically

symmetric approaches are retained, but by modifying the center of curvature to be that of the refractivity field of the atmosphere, instead of that of the Earth (i.e. the reference ellipsoid). A description and quantification of the differences found in the location of the center of curvature, and consequently on retrieved GPSRO observations will be shown. Finally, we compare the observation minus short-range forecast field statistics of GPSRO data (bending angles) with or without accounting for the presence of horizontal gradients in the atmosphere. Results are shown for different weather regimes in 2010, as well as for the Kompasu Typhoon (Sep 2010) event. In addition, data assimilation experiments have been conducted to evaluate the sensitivity of such modifications to the observation operators in the global deterministic prediction system. Results from case studies will be presented.

4C2.3 ID:5718 14:30

Testing and Evaluation of Regional EnKF Radiance Data Assimilation

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The Developmental Testbed Center (DTC) is conducting testing and evaluation of the Data Assimilation Research Testbed (DART) ensemble Kalman filter (EnKF) system for regional applications within an operational framework. In order to facilitate research to operations, a technique developed by research colleagues at NCAR/MMM for assimilating Advanced Microwave Sounding Unit (AMSU)-A radiances initialized with a limited-area EnKF will be evaluated and more radiance data will be added from additional sensors in order to determine if there is an added benefit. Previous tests have shown an improvement in basic forecast scores when assimilating AMSU-A radiance data, compared to assimilating conventional observations only. These tests were performed over a domain encompassing the Atlantic Basin during a one-month period in 2008. To build on current research, AMSU-B and Microwave Humidity Sounder (MHS) sensors will also be added following the existing technique, where the radiance forward operators, bias-correction coefficients, and quality control measures will be computed using the 3D-Var Weather Research and Forecasting Model (WRF) Data Assimilation System (WRFDA). Runs using AMSU-B and MHS in addition to AMSU-A will be tested extensively over the same domain and time period as the AMSU-A testing. Deterministic forecasts using WRF-ARW initialized from the ensemble-mean analyses from DART will be verified against both conventional PrepBUFR data and the ERA-interim reanalysis. Statistical significance testing as well as evaluation of the predictability of tropical cyclones within the domain will also be presented to determine if assimilating AMSU-B and MHS provide forecast improvement in addition to assimilating AMSU-A.

4C2.4 ID:5518 14:45

Impact of assimilating AMSU-A radiances on forecasts of 2008 Atlantic tropical cyclones initialized with a limited-area ensemble Kalman filter

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The impact of assimilating radiance observations from the Advanced Microwave Sounding Unit (AMSU-A) on forecasts of several tropical cyclones (TCs) was studied using the Weather Research and Forecasting (WRF) model and a limited-area ensemble Kalman filter (EnKF). Analysis/forecast cycling experiments with and without AMSU-A radiance assimilation were performed over the Atlantic Ocean for the period 11 August to 13 September 2008, when five named storms formed. For convenience, the radiance forward operators and bias-correction coefficients, along with the majority of quality-control decisions, were computed by a separate, pre-existing variational assimilation system. The bias correction coefficients were obtained from 3-

month offline statistics and fixed during the EnKF analysis cycles. The vertical location of each radiance observation, which is required for covariance localization in the EnKF, was taken to be the level at which the AMSU-A channels' weighting functions peaked. Deterministic 72-h WRF forecasts initialized from the ensemble-mean analyses were evaluated with a focus on TC prediction. Assimilating AMSU-A radiances produced better depictions of the environmental fields when compared to dropwindsonde observations and reanalyses. Radiance assimilation also resulted in substantial improvement of TC track and intensity forecasts with track-error reduction up to 16% for forecasts beyond 36 h. Additionally, assimilating both radiances and satellite winds gave markedly more benefit for TC track forecasts than the use of radiances alone.

4C2.5 ID:5483 15:00

Influence of Assimilating Satellite-Derived Atmospheric Motion Vectors (AMVs) on Analyses and Forecasts of Tropical Cyclone Track and Structure

Ting-Chi Wu [1], *Sharanya Majumdar* [1], *Hui Liu* [2], *Chris Velden* [3], *Jeff Anderson* [2]

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Given that tropical cyclones (TCs) spend most of their lifetimes over the ocean, their forecasts are crucially dependent on the accurate assimilation of satellite data. In order to provide an accurate representation of the TC structure, assimilation of high-resolution satellite data into mesoscale models is necessary. One example of such data is cloud-derived Atmospheric Motion Vectors (AMVs) from geostationary satellites. Operationally, the AMVs are derived from sequential images every 30 minutes, and these are processed hourly by CIMSS. When a TC is a potential threat to society, a 'rapid-scan' mode is activated, yielding even more frequent sequential images and therefore a higher volume of AMVs. In this study, the influence of assimilating hourly and rapid-scan AMVs into the Weather Research and Forecasting (WRF) model using the Ensemble Kalman Filter (EnKF) is investigated for the case of Typhoon Sinlaku (2008) during its period of intensification.

Three EnKF cycles, using 32 ensemble members with a resolution of 27 km on the analysis grid (and 9 km in the forward forecast model), are prepared. A 'Control' EnKF cycle is first produced with the assimilation of conventional observations (without radiances), but with the experimental CIMSS AMV data excluded. Next, a parallel EnKF cycle ('CIMSS hourly') that includes these AMVs is computed over the life cycle of Sinlaku. Finally, a third parallel EnKF cycle ('CIMSS hourly+RS') that includes both the hourly and rapid-scan CIMSS AMVs is produced. Rapid-scan AMVs were available during the second half of Sinlaku's life cycle.

In comparison to the 'Control', the 'CIMSS hourly' ensemble analyses generally produce lower track errors and better capture the rapid intensification. The 'CIMSS hourly' analyses exhibit a deeper warm core and stronger low-level vorticity and convergence than the 'Control', with values of mean sea level pressure that are generally more consistent with the best track. Analyses with respect to QuikSCAT winds and NRL P3 ELDORA radar wind will also be presented. A comparison of the respective steering flows reveals that the 'CIMSS hourly' analyses possess a generally more accurate northwestward flow, while the flow in the 'Control' analyses is typically more westward. The influence of assimilating the rapid-scan winds, and diagnostics of the covariance structure will also be presented.

4C2.6 ID:5818 15:15

Outcomes of the World Radiocommunication Conference 2012 (WRC-12) – Successes, Challenges and Opportunities for the National Meteorological and Hydrological

Services (NMHS)

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Radio-frequencies represent scarce and key resources used by NMHSs to measure and collect observational data upon which analyses, predictions and warnings are based; and to disseminate this information to governments, policy makers, disaster management organizations, commercial interests and the general public. In particular space-borne sensing of the Earth's surface and atmosphere plays an essential and increasingly important role in operational and research meteorology, and in the scientific understanding, monitoring and prediction of climate change and impacts.

Thanks to the hard work by the members of the WMO Steering Group – Radio Frequency Coordination (SG-RFC) during the 2008-2012 work cycle leading to WRC-12, and at the WRC-12 itself, the outcomes of WRC-12 on the 13 agenda items of interest were quite favorable to our community. A highlight was the recognition of the importance of Earth observation radiocommunication applications in the Radio Regulations (RR) themselves.

However vigilance and hard work to promote and defend use of spectrum by our community to meet current and future monitoring requirements must continue, while demand for spectrum increases. For example a critical agenda item for the next Conference (WRC-15) is about additional spectrum allocations to the mobile service. Facing current and emerging threats and lobbies representing huge economical interests, the meteorological community and 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 by our community (e.g. by satellites, radars, radiosondes).

This presentation will provide a brief summary of the outcomes of WRC-12 and of the radio-frequency challenges and opportunities to the NMHSs, namely associated with WRC-15.

Climate Change and the Carbon Cycle PART 2 / Changements climatiques et le cycle du carbone PART 2

Room / Endroit (Grand salon C), Chair / Président (Alvaro Montenegro), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C6.1 ID:5750 INVITED/INVITÉ 14:00

Carbon cycle dynamics since the Last Glacial Maximum: A study using the University of Victoria Earth System Climate Model

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The University of Victoria Earth System Climate Model (version v.9) is used to investigate carbon cycle dynamics from the Last Glacial Maximum (21000 years Before Present (BP)) to the beginning of the Industrial Revolution (150 BP). A series of simulations with prescribed and freely-evolving CO2 suggest that a combination of two factors, a faster overturning of the oceans during the interglacial and a release of carbon from deep-sea sediments, are likely responsible for a substantial proportion of the glacial-interglacial CO2 increase from 190 (23000 BP) to 280 ppm (150 BP). The simulations also indicate that a realistic glacial-interglacial change in the meridional overturning circulation can be generated without accounting for runoff from melting ice sheets. A series of model experiments also investigated the mechanisms behind the Holocene increase in CO2 after 8000 BP. Without the explicit representation of peatlands, permafrost, coral reefs, or human land use, the UVic model simulation of the natural carbon cycle over the period produced a decline in the atmospheric CO2 from 260 to around 250 ppm, in contrast to the increase from 260 to 280 ppm actually observed. Surprisingly, sensitivity simulations with global deforestation actually yielded lower CO2 concentrations (249-254 ppm) at 150 BP than the same simulations with no deforestation. Even without deforestation, the decrease in CO2 is highly sensitive to the configuration of land ice shelves near Antarctica, with more extensive land ice leading to deeper local circulation in the Southern Ocean, less Antarctic-generated bottom waters globally, and a higher atmospheric CO2 concentrations (260 ppm) at 150 BP. The 5-8 ppm contribution of ice shelf extent may well be an important contributor to the higher analogue CO2 levels during the Holocene interglacial, as current data and reconstructions suggests that these ice shelves are indeed more extensive today than during many previous interglacial periods.

4C6.2 ID:5471 14:15

Carbon-concentration and carbon-temperature feedbacks in CMIP5 earth system models

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The magnitude and evolution of two feedback parameters, which characterize feedbacks in the coupled carbon-climate system, are compared across eight earth system models (ESMs). The analysis is based on results from the biogeochemically-, radiatively- and fully-coupled simulations in which CO2 increases 1% per year. These simulations are part of the fifth coupled model intercomparison project (CMIP5). The carbon-concentration feedback parameter characterizes the strength of the land and ocean carbon sinks in response to the changes in atmospheric CO2 concentration and the carbon-temperature or carbon-climate feedback is a measure of the effect of temperature on the exchange of carbon between the atmosphere and the land and ocean carbon pools. Both flux and integrated flux based versions of the feedback parameters are compared. Results indicate that, on a global scale from the atmosphere’s perspective, the differences in carbon feedbacks among ESMs are dominated by the diverse response of the land carbon cycle components in the participating models. The range in the cumulative atmosphere-surface CO2 fluxes across models, in response to changes in atmospheric CO2 concentration and temperature, is three to four times larger over land than over ocean. The behaviour of flux-based feedback parameters is consistent with the physical and biological processes that govern the atmosphere-land and atmosphere-ocean fluxes of CO2. However, the integrated flux based feedback parameters are difficult to interpret because of the averaging involved.

4C6.3 ID:5527 14:30

Climate change commitment in EMIC AR5 simulations

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Different measures of climate change commitment have been proposed in the literature: the classic warming commitment from constant CO2 concentrations, and the climate change commitment from zero future greenhouse gas emissions. Simulations with coupled climate carbon cycle models have shown that global mean temperature remains approximately constant after elimination of CO2 emissions, in contrast to the continuing warming following stabilization of atmospheric CO2 concentrations. Here we present results from a model intercomparison effort undertaken in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. We analyze the long-term climate response for different climate change “commitment” simulations with a range of Earth system models of intermediate complexity. Simulations include “constant concentration commitment” experiments where atmospheric CO2 follows the Representative Concentration Pathways and their extension to 2300 and is held fixed thereafter, “constant emission commitment” simulations where CO2 emissions are held fixed at their 2300 value, and “zero emission commitment” simulations where anthropogenic CO2 emissions are set to zero after 2300 (with post-2300 non-CO2 forcings either constant or set to zero). We quantify the different measures of climate change commitment and discuss the reasons for inter-model differences.

4C6.4 ID:5493 14:45

Climate response to zeroed emissions of greenhouse gases and aerosols

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The climate response to scenarios of zero future greenhouse gas emissions can be interpreted as the committed future warming associated with past emissions, and represents a critical benchmark against which to estimate the effect of future emissions. Recent climate model simulations have shown that when emissions of carbon dioxide alone are eliminated, global temperature stabilizes and remains approximately constant for several centuries. Here, we show that when aerosol and other greenhouse gas emissions are also eliminated, global temperature increases by a few tenths of a degree over about a decade, as a result of the rapid removal of present-day aerosol forcing. This initial warming is followed by a gradual cooling that returns global temperature to present-day levels after several centuries, owing to the decline in non-CO2 greenhouse gas concentrations. We show further that the magnitude of the peak temperature response to zero emissions depends strongly on the uncertain strength of present-day aerosol forcing. Contingent on the climate and carbon cycle sensitivities of the model used here, we show that the range of aerosol forcing which produces historical warming that is consistent with observed data, results in a warming of between 0.25 and 0.5 °C over the decade immediately following zero emissions.

4C6.5 ID:5526 INVITED/INVITÉ 15:00

The Alberta oil sands and climate

Neil Swart, *Andrew Weaver*
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The claimed economic benefits of exploiting the vast Alberta oil-sand deposits need to be weighed against the costs of global warming caused by the associated carbon dioxide emissions. Here we quantify the carbon-dioxide induced potential for global warming contained in the Alberta oil sands in the context of global fossil-fuel resources. We estimate the carbon available for emissions from the oil sands based on a per-barrel carbon content multiplied by the number of barrels. To quantify the potential for global warming, we exploit known relations between cumulative carbon emissions and global mean temperature change. We also quantify the potential for warming, and other impacts, using a coupled carbon-climate model. To provide context we calculate the per-capita carbon footprint that would be achieved if the oil-sands proven reserve were utilized exclusively by the North American population or the Chinese population. The sizes of these oil-sands carbon footprints are compared to the footprint size compatible with restraining anthropogenic global warming to within the ‘safe limit’ of 2°C. The results show that infrastructure commitments to oil-sands usage, such as the Keystone XL or Northern Gateway pipeline, could have implications for climate policy. Recent estimates also show that an enormous global fossil-fuel total resource base is available to meet growing worldwide energy demand and we contextualize the oil-sands results by quantify the potential for carbon-induced warming for each resource. The behemoth coal resource is by far the most significant, containing 79% of the potential for future warming. We conclude that avoiding over 2°C of anthropogenic warming requires a rapid transition of global energy systems to non-greenhouse-gas-emitting sources, while avoiding commitments to new infrastructure supporting dependence on fossil fuels.

4C6.6 ID:6184 15:15

Constraining the ratio of global warming to cumulative carbon dioxide emissions using CMIP5 simulations

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The ratio of warming to cumulative emissions, or the Transient Response to Cumulative Emissions (TRCE) is approximately independent of time and emissions scenario, and directly relates emissions to climate effects. It is therefore a potentially important tool for climate mitigation policy. We find that the TRCE of twelve CMIP5 models ranges from 0.8 to 2.4 K/TtC, a broader range that that of a set of previous generation of carbon-climate models. We use temperature observations together with CMIP5 simulations to constrain an estimate of CO2-attributable warming, and divide this by published emissions estimates to obtain an observationally-constrained estimate of TRCE.

Ocean Observation Systems / Systèmes d'observation des océans

Room / Endroit (Symphonie 1), Chair / Président (Michael Ott), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C5.1 ID:5912 14:00

Ocean Observation Systems – Interagency Collaboration

Michael Ott

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As satellite data become less expensive and more applicable to ocean applications, they are an increasingly important component of observation efforts at Fisheries and Oceans Canada (DFO). At the same time, ground-truthing satellite data, as well as long-term and Arctic monitoring needs, necessitate ongoing and widespread in-situ measurement programmes. Increased interagency cooperation is needed to ensure that both satellite-based and in situ ocean observations systems are effective and efficient. This paper will describe some of DFO's ongoing collaborations and highlight new initiatives to strengthen links between DFO and other departments and agencies.

4C5.2 ID:5913 14:15

Sustaining Arctic Observing Networks (SAON)

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The Sustaining Arctic Observing Networks (SAON) initiative of the Arctic Council is "a process to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environmental, social, economic and cultural issues". An inventory of monitoring in the Arctic has been done and based on this initial phase of gathering information, the process is now moving forward with key initiatives proposed and delivered by the country participants. This paper summarizes the current status of SAON and Canada's involvement in this initiative.

4C5.3 ID:5794 14:30

Cross-validation of satellite data with in situ ocean data from Argo profiling floats

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Freely drifting, profiling Argo floats are fairly uniformly distributed in the world ocean, with an average separation distance of 300 km. In their standard configuration, these floats are equipped with pressure, temperature and conductivity sensors. But some floats are also equipped with extra sensors such as optical sensors. We will discuss the potential of using Argo floats for providing in situ data of near-surface temperature, salinity and ocean colour that can help calibrate space-based measurements of these parameters from Earth-orbiting satellites.

4C5.4 ID:5805 14:45

Initial Findings of MINIMET (Surface Velocity Program Buoy with a Sonic Anemometer)

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With the increasing interest in the Arctic region and to fulfil part of the monitoring requirement of the Arctic Ocean, known as the METAREA (MET) initiative, the MSC has planned to expand the existing drifting buoy network to the Canadian Arctic to form the Canadian Arctic Buoy Array (CABA). This network of consumable buoys will allow the collection of real-time observations of surface pressure, temperature, sea or ice temperature and also track the movement of ice pack via hourly position reports. Some of significant challenges of the planned expansion in CABA are extreme weather conditions, lack of inexpensive technology to measure all required meteorological parameters and complex and expensive logistics. As a result there haven't been sufficient meteorological measurements, especially wind measurements, from the Arctic regions to feed the forecasters and to validate satellite data (i.e. SAR winds). The sources of wind data are from few land based surface weather stations in the Arctic region and the limited number of ships traveling in the Arctic which are equipped with Automatic Volunteer Observing Ship (AVOS) systems. Both of these observing systems are expensive to install and require regular maintenance to obtain reliable data.

To prepare for this challenge, MSC is currently evaluating the performance of a low cost solution; a Surface Velocity Program(SVP) Buoy with a Sonic Anemometer (MINIMET) that can measure air (or sea surface) temperature, atmospheric pressure, wind speed and wind direction powered by an alkaline battery pack. The objective of this test is to evaluate the performance and survivability of the alkaline battery pack and wind measurements in the Arctic like extreme weather situations.

As a prototype, two MINIMET buoys are installed, one on the ground and the other on a 2m high platform, in a surface land monitoring station (Gimli surface weather station, Manitoba) compound. Hourly data collection via Iridium satellite started in early January 2012 and will continue until the end of June 2012. Hourly data from the two MINIMET buoys will be compared to the data from the Gimli surface weather station. Alkaline battery pack voltage will be monitored against the atmospheric temperature and other relevant parameters to evaluate the survivability of the inexpensive power source. Analysis of some results will be available by the time of the presentation.

4C5.5 ID:5795 15:00

Northeast Pacific ocean responses to an extreme storm event: A real-time view using Neptune Canada high frequency data.

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One much-discussed advantage of cabled ocean observatory systems over traditional shipboard or moored instruments is the ability to make continuous observations with multiple instruments during high-energy storm events. This presentation examines data recorded by NEPTUNE Canada instruments in the NE Pacific Ocean during an extreme storm event that occurred from 21-23 January 2012. . We present a multidisciplinary, high resolution view of physical, chemical and biological characteristics of the water column as storm energy rose and then subsided over a ten day period. This presentation highlights the value of long-term real-time, high resolution, multidisciplinary ocean observations to better understand naturally driven oceanographic phenomena and relationships of ocean processes to weather events and climate change at various temporal and spatial scales

4C5.6 ID:5467 15:15

An analysis of the time-varying heat, salt and volume budget in an oceanic control volume.

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This talk continues the analysis of a control volume in the Gulf of Alaska that was first presented one year ago. In the previous talk analysis was shown that established that it was possible to use the Argo array to compute the horizontal divergences of heat, salt and volume in a control volume away from boundary currents. This talk will look at the time variability of these balances. Specifically, the time variable part of the

volume divergence allows a direct computation of the vertical velocity varying over a period of 8 years. Geostrophic calculations allow computation of the horizontal divergence of heat and salt which, when coupled with the fluxes through the bottom of the control volume allow the time variability of the total salt content to be related to the divergence and vertical velocity. Both of these are necessary to balance the heat budget, the two terms (horizontal divergence and vertical flux) contribute 50% each to the total variability in the system.

Impacts of Intermittent Natural Plume Emissions: Detection and Prediction / Conséquences des émissions de panaches naturels intermittants : détection et prévision

Room / Endroit (Symphonie 2), Chair / Président (Sylvie Gravel), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C7.1 ID:5625 14:00

The Western Canada BlueSky System: A Framework for Forecasting Wildfire Smoke

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In 2007, a inter-agency partnership began the development of a system for forecasting the spread of smoke from wildfires within British Columbia (BC) and Alberta based on the US Forest Service BlueSky framework. The system couples information on actual forest-fire hot spots observed by satellite, forest fuel loads compiled by the Northern Forestry Research Center, algorithms to predict smoke emissions and rise, high-resolution numerical weather forecasts provided by the University of British Columbia, and pollutant-dispersion modeling. In 2010 the Western Canada BlueSky system began producing smoke forecasts for BC and Alberta that were updated daily during the wildfire season, and made available through a BC government website (http://www.bcairquality.ca/bluesky). This system is a first in Canada.

The positive experience with the 2010 pilot system resulted in further support for development which included an extension of the modeling domain using a nested grid meteorological model (MM5) to cover all of western Canada including NW Ontario, portions of the Yukon, Northwest Territories, Nunavut as well the bordering northern U.S. states, and the production of forecasts twice a day in order to use the latest hotspot detection information. For 2012 the SmartFire2 fire processing system will be added, as well as the development of a web-based planning tool for assessing the smoke impacts from prescribed fires.

Finally, a qualitative evaluation of the forecasts indicate that the system is producing output that is consistent with the capability of the components (hotspot detection, meteorological forecast, transport and

dispersion). Space-time paired comparisons to PM2.5 monitoring data shows errors in the details of the magnitude and timing of events, although the overall patterns of impacts are reasonable under situations of extensive smoke from large fire complexes.

4C7.2 ID:5838 14:15

Caractérisation, modélisation et validation de corrections atmosphériques en présence de panache de fumée.

Shems Zidane [1], *Norm O'Neill* [1], *Martin Bergeron* [2], *Alain Royer* [1]
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La télédétection passive dans le visible et proche infrarouge est fortement perturbée par les effets atmosphériques. Le recours à des modèles atmosphériques est une solution standard habituelle et fiable pour corriger les images de ces effets et d’extraire la réflectance au sol pour chaque pixel de l’image. Cependant les modèles atmosphériques ne tiennent compte que de situations atmosphériques standard, et leur corrections ne sont plus valide lorsque nous sommes en présence de conditions atmosphériques non-standard comme par exemple la présence d'un panache de fumée. Cette étude est basée sur des images multi-altitudes aéroportées acquise en juillet 2004 en présence d'un panache de fumée dans la région de Saint-Jean-sur-Richelieu (Québec, CANADA). Un protocole de modélisation du panache de fumée a été réalisé en se servant de données auxiliaires permettant l’élaboration d'une méthodologie robuste adaptée à cette problématique et l'implémentation du panache de fumée dans notre modèle atmosphérique. L'approche multi-altitude permettant de caractériser les mêmes cibles au sol avec des contributions de l’atmosphère variant selon l'altitude nous permettra de contrôler la modélisation du panache de fumée. En fonction de cette modélisation, nous montrons que l'erreur en réflectance avec le modèle atmosphérique original et après y avoir implémenté le panache est considérablement minimisée.

4C7.3 ID:5755 14:30

Applications of the BlueSky smoke modeling framework: U.S. and Canada, real time and retrospective

Sean Raffuse [1], *Sim Larkin* [2], *Ken Craig* [1], *Tara Strand* [3], *Steve Sakiyama* [4]
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The BlueSky smoke modeling framework is used to simulate cumulative smoke impacts from wildland, prescribed, and agricultural fires across a region. Developed by the U.S. Forest Service, BlueSky is not a model itself, but an open- source, modular framework for linking state-of-the-science models of meteorology, fuel loading, fuel consumption, pollutant emissions, and smoke transport. BlueSky-enabled predictive models have been implemented across the United States and western Canada for real-time air quality forecasting. Interactive BlueSky web applications are available for prescribed burn planning. Coupled with its sister application, the SmartFire 2 fire information system, BlueSky is also used retrospectively to develop the open burning portion of the U.S. Environmental Protection Agency’s National Emissions Inventory. To support Parks Canada's smoke management needs, Canadian fire weather and fire behavior prediction models have recently been added to BlueSky. We present the BlueSky framework and SmartFire 2 and discuss recent applications, advances, and plans.

4C7.4 ID:5366 14:45

A Plume–rise Model for Wildland Fires

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This presentation describes a methodology to predict plume-rise from wildland fires. First, an energy balance is outlined to estimate the energy released into the atmosphere. Second, a thermodynamic method is described to estimate the plume rise based on the energy input and the environmental lapse rate.

Following Byram's equation, the energy released from a wildland fire can be calculated from the fuel consumed and the area burned. This energy is expended in various processes, including the energy required to evaporate away fuel moisture, the energy required to heat the fuel to combustion temperature, the energy injected into the surface, the energy lost due to radiation, and the energy released into the atmosphere. Also, not all the potential energy of the fire realized due to incomplete combustion, while heat from the plume is lost over time to the surrounding environment due to black body radiation.

The energy released into the plume can then be used to calculate plume rise. This is equated to energy per unit mass of dry air, which then modifies the column of air above the fire from the environmental lapse rate to dry adiabatic. The tephigram, a thermodynamic diagram, is used to derive a numerical solution for the penetration height.

Predicted results are compared with observations from a smoke plume study being conducted in Alberta, which uses hand-held inclinometers and photographs taken by lookout tower personnel to measure smoke plume heights.

4C7.5 ID:5651 15:00

Wildfire Emissions in the Canadian GEM-MACH Air Quality Forecast Model

Jack Chen [1], *Sylvie Gravel* [1], *Radenko Pavlovic* [1], *Kerry Anderson* [2], *Al Pankratz* [1]
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A new emissions framework for wild and prescribed fire emissions was recently developed for Environment Canada's GEM-MACH air quality forecast model. The emissions framework incorporates modules from the US Forest Service's BlueSky system for fire events in the US, and the Canadian Forest Service's CWFIS (Canadian Wild Fire Information System) for fire events across Canada. The system produces hourly VOC, NOx, CO and particulate matter (PM) emissions data by fire location. The emissions are incorporated into the GEM-MACH model as major sources and individual hotspot emissions are parameterized into elevated layers for transport and chemistry during model run-time. The system was applied to simulate a historical fire event in summer 2010 in British Columbia, Canada. The presentation will outline the new emissions framework, present quantitative comparison of wildfire emissions, and evaluate the implementation of the plume-rise algorithm on air quality forecast results.

4C7.6 ID:5648 15:15

Evidence of sharp features in the Fukushima plume over south-western British

Columbia

Réal D'Amours [1], *Alain Malo* [2], *Jean-Philippe Gauthier* [2], *Gilles Mercier* [2]
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On March 19 2011 and during the following days, a plume of radioactive Xenon (133Xe) at very low concentration was observed over South-western British Columbia. The plume was seen on Health Canada's radiation surveillance network, as well as in an aerial survey performed by Natural Resources Canada along a 350km track just off the west coast of Vancouver Island. All measurements pointed to the existence of distinct spatio-temporal features in the Xenon cloud, which had originated from the Fukushima nuclear power plant several days before, and had travelled thousands kilometres across the Pacific ocean.

Modelling using the Canadian Meteorological Centre Lagrangian Dispersion Model indicates that these features were produced by the passing of elongated plume filaments spiralling around a low-pressure system that had moved across the Pacific.

We show that the model results are highly correlated with 133Xe observations, demonstrating the high accuracy of the CMC analysed wind field over the Pacific. The significance of these results in the context of modelling lateral mixing and horizontal diffusion, and their usefulness in assessing the Xenon source term are also discussed.

Renewable Energy – The Important Role of Atmospheric Science PART 2 / Énergie renouvelable : l'importance des sciences de l'atmosphère PARTIE 2

Room / Endroit (Symphonie 3A), Chair / Président (Joël Bédard), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C1.1 ID:5781 14:00

High horizontal and vertical resolution limited area model: Near surface and wind energy forecast applications

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As harvesting of wind energy grows, so does the need for improved forecasts from the surface to the top of wind turbines. In order to improve in this layer mesoscale forecasts of wind, temperature, and dew point temperatures, two different approaches are examined in this study. In the first experiment, the vertical resolution of a Limited Area Model with 2.5km grid spacing (LAM-2.5km) is significantly increased near the

surface to better represent profiles in that layer.

In the second experiment, prognostic variables for land and ocean surfaces are initialized using results from an external land surface model system (called GEM-Surf), and from a regional ocean model.

It will be shown that increasing the vertical resolution near the surface leads to improved temperature and dew point temperature forecasts at the surface and in the wind turbine layer. For winds, improvements are more modest, as they are limited to the gradient measured across the span of the vertical wind turbine blades. The replacement of operational surface analyses with high resolution analyses obtained from GEM-Surf is found to improve summer dew point temperature forecasts. It will also be shown that changes in soil moisture analyses explain the bulk of the improved dew point forecasts.

4C1.2 ID:5670 14:15

Prediction of Wind Using Model Data

Michael Abbott , *Terry Bullock* , *Niaz Mohammed* , *David Bryan* , *William Henson*
(Presented by *William Henson*)
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In today's society, the prediction of wind for the production of energy has become an important factor. The recent disaster in Japan, the flooding of large areas of land for hydropower and the production of greenhouse gases by conventional energy production processes illustrate why there are advantages in using wind energy. However, the main drawbacks of wind energy are that it is variable and difficult to forecast.

AMEC has undertaken the Net Available Power centralized wind energy forecast project in order to investigate the predictability of wind for use in wind energy production. Nalcor Energy provided observation data from Hawke Hill, Newfoundland and additional data was obtained from several different Numerical Weather Prediction (NWP) models (both publicly available models and models run in-house at AMEC). The observation data were compared to numerous models and model runs, including GFS, GEM/LAM, ensembles and high temporal and spatial resolution (down to 10 minutes and 1 kilometre) WRF model data. A variety of statistical post-processing techniques were also used including multi-linear, non-linear, time lagging, neural network and decision trees to fit the various data sets and obtain optimal estimates of the wind speed.

The results from the NWP model runs and the post-processing techniques will be presented and explained as well as discussing the challenges of wind prediction in Newfoundland.

4C1.3 ID:5611 14:30

A simple renewable energy management model using ensemble NWP data as input

Lewis Poulin
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Forecast data from multi-member NWP ensemble systems can be used to generate probabilistic forecasts for decision-making and risk management tools. This presentation offers a prototype decision-making system using NWP ensemble data as input to highlight how a decision-making system could contribute to the management of energy based activities.

Our example is based on an energy efficient residence with access to renewable energy. The residence is assigned a daily energy requirement in support of its activities. There is interest by the occupants to maximize and optimize their use of available renewable energy. To help plan and then schedule the building's activities, ensemble NWP parameters are retrieved and processed to generate a forecast of how much potentially available renewable energy is forecast in the coming days. Along with this forecast a level of confidence is also calculated and then used as part of the decision-making process to prioritize which activities should be undertaken and when.

Coupling the building's daily energy needs with a forecast of available renewable energy that includes an associated confidence parameter may allow for the building and its occupants to manage energy-based activities in a more dynamic manner in order to take advantage of available renewable energy. For example, if the decision-making system detects more than enough energy for one day and at the same time it also forecasts a likely shortfall of energy in the days ahead, then the decision system could recommend, with an associated level of confidence, to either stockpile the energy for the coming days or perhaps to execute more activities on the day(s) when excess energy is available. Such decision-making systems that make effective use of ensemble NWP data could, for example, help extend the concept of "just in time delivery" into the renewable energy sector by enhancing readiness for buildings to take proper advantage of energy delivered to the building by the atmosphere. If decision-making systems can make it possible to [increase,reduce] the building's activities when there is [more,less] available renewable energy, then it can be explored if smaller renewable energy generating systems could be used and as a result help make renewable energy more accessible.

Arriving at sophisticated and automated types of decision-making systems using ensemble NWP data is not always easy and there are benefits to walking through simple examples such as this one to better understand the concepts.

4C1.4 ID:5668 14:45

Improving the Analysis of Wind Turbine Interactions with Weather Radar through the Addition of GIS Tools

Jim M.c. Young , *Carolyn Rennie* , *Norman Donaldson*
(Presented by *Carolyn J. Rennie*)
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The National Radar Program, a section of the Meteorological Service of Canada, is the contact for wind energy proponents to obtain recommendations on possible interactions between Canadian weather radars and wind turbines. Presently CanWEA and the Radio Advisory Board of Canada direct wind farm proponents to contact Environment Canada for consultation. Wind turbines in the line of sight of scanning weather radar pose many problems such as Doppler signal degradation, blockage, and multi-path scattering. Existing Doppler clutter filters are most effective on stationary targets but cannot effectively remove echoes caused by reflective rotating turbine blades. Due to the exponential growth of proposals received, it has become a priority to improve preliminary analysis tools to provide quick initial responses to proponents. The integration of GIS into the existing in-house analysis tool has allowed the creation of easy to use visibility maps of each radar site. The analysis tools use a digital elevation map and models the curvature of the Earth to determine point locations indicating the height of a turbine that will be visible to the radar. These visibility maps will be available on a public website to be used by industry for initial assessment. GIS tools have also aided in the creation of radar coverage maps that take into account blockage caused by terrain. These new GIS maps can provide industry, forecasters and radar users an improved understanding of radar products and visibility of obstructions.

4C1.5 ID:5758 15:00

Atmospheric icing severity

Fayçal Lamraoui [1], *Guy Fortin* [2], *Jean Perron* [1], *Robert Benoit* [3], *Christian Masson* [3]
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Meteorological forecasting is always a primary concern, because of the major impact that different meteorological conditions may cause over time. Environmentalists find wind turbine energy a good alternative for clean energy. It is noticed that in specific regions and time periods, high potentials of wind energy correspond with high potentials of atmospheric icing. Icing events which occur in northern countries endanger transportation, telecommunication and therefore generate negative effects in the production of wind energy. Using various feasible tools (observations, modeling), a series of studies have been done continuously in order to understand the atmospheric icing from different perspectives. The best way to avoid dangers of atmospheric icing is to locate and map it. The goal in this study is to create a tool that will map atmospheric icing which is based on ice quantification, its accretion and its frequency; therefore identifying the potential risk level of icing. Two cases of study are investigated, which involve two topographically contrasting sites; the January 1998 ice storm over the Montreal region and the January 1999 icing event over Mont-Belair site. In addition, an icing severity index map is represented in this study that shows the Gaspésie region and its surrounding area. This map is based on the quantification of icing from different meteorological variables of NARR data through the investigation of icing climatology. Limited-Area mesoscale model GEM-LAM and a statistical downscaling of NARR data are used for icing calculation at high resolution. The objective in this study is to provide the wind energy industry with a map of icing events that occurred historically, which can display parameters that describe the intensity and severity of icing events over a 32 year time period, specifically the winter months (December, January, February and their three months average) from 1979 to 2010. This detailed information could be used to estimate the energy loss due to such events, as well as the uncertainties on the projected energy yielded in a wind energy project

4C1.6 ID:5847 15:15

Modeling of ice throw from wind turbines

Sumita Biswas [1], *Peter Taylor* [2]
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Ice throw from wind turbines is sometimes a concern in the siting and construction of wind turbines near roads, residences or other areas with public access. The primary focus of this research project is to apply predictive models of ice throw (such as the one described in Biswas et al, 2011) in order to determine the zone of impact surrounding a wind turbine. The ice throw model was been developed to calculate the impact locations of ice fragments thrown from a rotating wind turbine under different conditions. A range of model results were obtained by assigning values of different parameters such as initial position, mass, density and drag coefficient of the ice fragment. Other variables considered include meteorological conditions and wind turbine specifications. Results show that drag coefficient, frontal area and mass of ice fragment together determine the trajectory of the ice fragment. In combination with wind information one can then determine the probability of impacts in the area surrounding either a single turbine or within an array of turbines. Coupled with, for example, traffic information, one can then estimate the likelihood of ice fragment impacts with vehicles as well as impacts on stationary structures.

Sumita Biswas, Peter Taylor and Jim Salmon (2011), A model of ice throw trajectories from wind turbines, Wind Energy, Article first published online : 17 NOV 2011, DOI:10.1002/we.519

Operational ice-ocean analysis and prediction PART 2 / Analyse et prévision opérationnelles glace-océan PARTIE 2

Room / Endroit (Ovation), Chair / Président (Mark Buehner), Date (01/06/2012), Time / Heure (14:00 - 16:30)

4C3.1 ID:5409 INVITED/INVITÉ 14:00

Evaluation of real time and future forecasting systems at Mercator Océan: Overview and recent improvements at the global and regional scales

Olivier Le Galloudec [1], *Lellouche Jean-Michel* [1], *Garric Gilles* [1], *Tranchant Benoît* [2], *Greiner Eric* [2], *Bricaud Clément* [1], *Drévillon Marie* [1], *Regnier Charly* [1], *Reffray Guillaume* [1], *Benkiran Mounir* [2], *Bourdallé-Badie Romain* [1], *Chanut Jérôme* [1]

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Since December 2010, Mercator Ocean operates in real time new versions of the global system at ¼° and the Atlantic and Mediterranean system at 1/12° nested in the global one. Both new analysis and forecasting systems deliver weekly and daily services in the framework of the MyOcean project. Many improvements concern the ocean/sea-ice model (NEMO code) and the assimilation scheme (reduced order Kalman filter). Moreover, a method of bias correction based on a variational approach is used. In addition, two others systems are currently operated in real-time. Since August 2010, a global 1/12° system delivers weekly services. This system does not benefit from all recent improvements but offers a new perspective on the global ocean mesoscale predicting. Since March 2011, a high resolution system at 1/36° without assimilation, nested in the Atlantic and Mediterranean “zoom”, covers Iberian-Biscay-Irish region. It includes high frequencies processes and is able to reproduce small structures like tidal fronts or upwelling filaments. After a description of the recent systems, the validation procedure is introduced and applied to the current and future systems. It is shown how the validation impacts on the quality of the systems, and how quality check and data source impacts as much as the systems design (model physics and assimilation parameters). The validation reveals that the systems under development still suffer from a drift in spite of overall improved statistics. All monitoring systems are close to Sea Level Anomaly (SLA) observations with forecast (range 1 to 7 days) RMS difference of 7cm. It is smaller than the intrinsic variability of the SLA observations. The dominant source of error in sea level comes from the uncertainty in Mean Dynamic Topography. The more advanced global system gives an accurate description of water masses almost everywhere between the bottom and 500m. Between 0 and 500m, departures from in situ observations rarely exceed 1°C and 0.2psu. Exceptions concern some high variability regions like the Gulf Stream or the Eastern Tropical Pacific. Most departures from SST observations do not exceed the intrinsic error of the observations.

4C3.2 ID:5635 14:30

Improvements to an automated sea ice analysis system.

Alain Caya , *Mark Buehner* , *Tom Carrieres* , *François Roy*
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An automated sea ice analysis system has been developed to provide guidance in the planning of safe navigation in ice infested waters. The same system can also provide gridded sea ice concentration analyses to numerical models for weather prediction. The system uses a variational approach to assimilate various sources of observations related to sea ice. A six-hour persistence forecast from the previous analysis provides the background ice concentration field used during the analysis. The first version of the system assimilates sea ice concentration data derived from passive microwave observations (AMSR-E and SSM/I), image analyses and daily ice charts from the Canadian Ice Service. This presentation will describe the results from testing of several major improvements to the system. The improvements include the assimilation of SSM/IS and ASCAT satellite observations, as well as the use of a state-of-the-art sea ice model to generate the background field. The addition of sea ice concentration retrievals from SSM/IS data from 3 satellites gives more robustness to the system and improves the quality of the sea ice concentration analysis. Since ASCAT data do not suffer from the same limitations as passive microwave data, especially during the summer season, the 2 datasets complement each other leading to additional improvements. While providing model estimates of ice thickness and other sea ice parameters, the effect of replacing the persistence forecast with a sea ice model on the sea ice concentration analysis is assessed.

4C3.3 ID:5823 14:45

Assimilation of sea-surface temperature observations during 2004 into an eddy permitting model of the North Atlantic Ocean

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We assess the influence of the assimilation of multisatellite remotely sensed sea-surface temperature observations into the general circulation model of the North Atlantic Ocean. For this purpose an Ensemble Optimal Interpolation (EnOI) data assimilation scheme has been developed. The scheme is similar to BODAS scheme (Oke et. al. 2008) and relies on multivariate seasonally varying background-error covariance matrix derived from a long hindcast with realistic atmospheric forcing. The model distinctive feature is a spectral nudging scheme which nudges the model's seasonal climatology of temperature and salinity to their observed climatology. The spectral nudging results in significant reduction of the model bias. However, in the eddy dominated Gulf Stream region, the model also has to take into account the error of the day. We show that assimilating the daily SST observations can further reduce the error and improve accuracy of nonlinear model analysis and forecast.

4C3.4 ID:5576 15:00

Evaluation of NEMO Oceanic Simulations and High-resolution Coupled Weather Forecasts in the Gulf of St. Lawrence

François Roy [1], *Gregory Smith* [2], *Simon Senneville* [3], *Frédéric Dupont* [1], *Jérôme Chanut* [4], *Amin Erfani* [1]
(Presented by *Francois Roy*)
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We evaluate a regional configuration of NEMO for oceanic simulations of the Gulf of St. Lawrence (GSL) and compare results with the Saucier et al. (2009) model running operationally at the CMC (thereafter MoGSL). We apply recent NEMO developments in regional ocean modelling including variable volume, non-linear free surface, tides, and high-order advection and TKE schemes. A simulation of oceanic seasonal cycles without data assimilation is evaluated and compared with results from the CMC's pseudo-analysis system (based on MoGSL) providing daily initial conditions to a regional operational coupled weather forecast system. NEMO gives results of a similar accuracy to MoGSL for SST and ice concentration and thickness. Typical averaged circulation patterns are also reproduced with similar tidal elevation phases and amplitudes. Additionally, seasonal patterns of vertical temperature and salinity profiles evolve in a stable (non-drifting) and similar way as in MoGSL, suggesting a comparable potential for realistic operational applications. Preliminary coupled weather forecast results are shown compared to our current operational system. Additionally, the sensitivity of forecasts to model resolution is investigated using a 1km version of NEMO.

Diagnostic Analysis of Weather Systems / Analyse diagnostique des systèmes météorologiques

Room / Endroit (Grand salon A), Chair / Président (Shawn Milrad), Date (01/06/2012), Time / Heure (16:30 - 18:00)

4E2.1 ID:5394 16:30

Climatological Aspects of Ice Storms in the Northeastern United States

Christopher Castellano [1], *Lance Bosart* [1], *Dan Keyser* [1], *John Quinlan* [2], *Kevin Lipton* [2]
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Ice storms are among the most hazardous, disruptive, and costly meteorological phenomena in the northeastern U.S. The accretion of freezing rain during ice storms endangers human lives, undermines public infrastructure, and adversely impacts local and regional economies. Due to the combined influence of synoptic, mesoscale, and microphysical processes, ice storms also present a major forecast challenge. Empirical evidence suggests that operational models and forecasters often underestimate the extent and duration of freezing rain for scenarios involving frozen, mixed, and liquid precipitation types. In consideration of these societal impacts and forecast issues, we have developed a 17-year (1993–2010) climatology of ice storms in the northeastern U.S. The results of this climatology will be applied toward: 1) determining the synoptic and mesoscale environments conducive to ice storms, and 2) developing methodologies to improve the operational forecasting of potential ice storms.

The ice storm climatology is constructed from NCDC Storm Data, NCDC's Integrated Surface Database,

and NCEP/NCAR reanalysis data. First, we establish a history of ice storms impacting each county warning area within the domain of the Northeast Regional Climate Center. This procedure allows us to analyze the temporal and spatial variability of ice storms in the northeastern U.S., as well as classify ice storms by size, severity, precipitation regime, frontal structure, and associated cyclone and anticyclone tracks. Next, we create synoptic composites to examine the dynamic and thermodynamic fields associated with ice storms in each county warning area. Predominant features in these composites suggest how large-scale circulations, thermal boundaries, moisture transport, and the associated quasi-geostrophic (QG) forcing establish synoptic environments favorable for freezing rain. Moreover, the recognition of key synoptic ingredients several days in advance is crucial to provide ample warning and ensure adequate preparation for an impending ice storm.

Although freezing rain typically occurs under preferred synoptic conditions, mesoscale processes such as cold-air damming, terrain–flow interactions, and frontogenesis ultimately determine the evolution and persistence of freezing rain events by modifying the dynamically and thermally forced synoptic-scale circulations and the associated QG forcing on regional and local scales. Therefore, a multiscale analysis is necessary to identify important synoptic–mesoscale circulation linkages and to differentiate among the various mechanisms responsible for freezing rain. The anticipated findings from the multiscale analysis will build upon existing conceptual models and provide operational forecasters with increased awareness of the synoptic and mesoscale processes that influence the initiation and evolution of ice storms across the northeastern U.S.

4E2.2 ID:5369 16:45

Appalachian Lee Troughs and their Association with Severe Thunderstorms

Daniel Thompson [1], *Lance Bosart* [1], *Daniel Keyser* [1], *Thomas Wasula* [2], *Matthew Kramar* [3]

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Appalachian lee troughs (ALTs) can play an important role in the development of convective storms, some of which may become severe, in the region to the lee of the Appalachians. Accurately forecasting the location, mode, and severity of convection associated with ALTs is important due to the proximity of the convective initiation region to the densely populated U.S. Eastern Seaboard. Forecasting convection associated with ALTs can be challenging, especially in weak upper-level flow regimes that are characteristic of the region to the lee of the Appalachians during the summer months. To investigate the structure of ALTs, 13 cases of ALT events associated with severe convection that affected the Sterling, VA (LWX), County Warning Area between May and September were analyzed using 0.5º resolution gridded data from the CFSR (Climate Forecast System Reanalysis). A climatology of ALTs in the lee of the Appalachians from the Carolinas northeastward to southern Pennsylvania, referred to as the "ALT Zone," was constructed based on criteria derived from the following low-level features that are common to the 13 cases: (1) a wind component orthogonal to and downslope of the mountain barrier, (2) a thickness ridge, (3) a thermal vorticity minimum, and (4) a geostrophic relative vorticity maximum. Horizontal maps of thickness and thermal vorticity, as well as vertical cross sections of geostrophic relative vorticity and potential temperature, suggest that ALTs are shallow, warm-core phenomena. The purpose of this presentation is twofold. First, it will show the results of the ALT climatology by presenting a scheme for defining ALTs based on the magnitude of their sea level pressure and low-level thermal anomalies. Second, it will examine the spatial and temporal distribution of severe local storm reports in the ALT Zone and assess CAPE and vertical wind shear at the location of the first storm report of the day. The time of the first storm report of the day and its median location in CAPE/vertical wind shear phase space varies by month and latitude. The peak time for the first storm report of the day occurs between 1800 and 1900 UTC (2000 and 2100 UTC) in the southern

(northern) portion of the ALT Zone. Greater median CAPE (vertical wind shear) at the first storm report of the day occurs in June, July and August (May and September) and in the southern (northern) portion of the ALT Zone.

4E2.3 ID:5370 17:00

The role of anticylones in replenishing surface cold air and modulating severe freezing rain event duration

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Freezing rain (FZRA), a hazardous meteorological phenomenon, is associated with airflows from both cyclones and anticyclones. Though researchers have placed primary emphasis on the cyclone's role in FZRA, we examine the anticyclone's role in transporting near-surface cold air. More specifically, we study its impact on the duration of FZRA in a region of orographically enhanced vulnerability, namely at Quebec City (YQB). The city is located in the St- Lawrence River Valley, an active zone of freezing rain, owing to orographic influences that promote pressure driven channeling. Within this region, we define a severe freezing rain event by a minimum duration threshold of six hours. We find 47 such cases during a 30-year period (1979-2008). We then partition these cases into categories based on precipitation phase change and 850hPa geostrophic relative vorticity. Results show that the duration of freezing rain is determined primarily by the intensity and location of the anticyclone. These are inherent characteristics required to maintain near-surface cold air. Identifying these anticyclonic features provides a novel approach to determine the potential severity of FZRA events. This, in conjunction with current forecasting techniques, could better prepare emergency crews and the general public.

4E2.4 ID:5285 17:15

Precipitation modulation by the Saint Lawrence River Valley in association with transitioning tropical cyclones

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The St. Lawrence River Valley (SLRV) is an important orographic feature in Eastern Canada that has been shown previously to contribute to pressure-driven wind channeling and locally enhanced precipitation, predominantly in the cold season. We qualitatively assess the impact of the SLRV on named tropical cyclones that have undergone or are undergoing extratropical transition and tracked near the SLRV. Such cases can result in heavy precipitation during the warm season that causes risks to life and property. Katrina (2005) is one example of a storm that produced 55% of Montreal, Quebec's total August rainfall in only one day. From National Hurricane Center best track data, we find that 39 named tropical cyclones had tracked to within 500 km of the SLRV from 1979-2010. Utilizing the NCEP North American Regional Reanalysis (NARR), our results show that 27 (Group A) of the 39 cases had large values of ageostrophic frontogenesis predominantly oriented parallel to the long axis of the SLRV. For a subset of 11 Group A cases from 2004-2008, a qualitative comparison of NARR output with high-resolution (15 km) gridded Canadian precipitation shows that enhanced areas of precipitation were also oriented parallel to the SLRV and were concomitant with the largest ageostrophic frontogenesis. The suggested physical pathway to enhanced ascent and precipitation within the SLRV during Group A cases is rooted in 1) near-surface ageostrophic frontogenesis, and 2) weak atmospheric stability in the SLRV. The valley-enhanced near-surface ageostrophic frontogenesis is due to an along- valley pressure gradient established by the approaching named tropical

cyclone, which induces pressure-driven wind channeling within the valley. Regions of weak stability are often co-located with the valley-enhanced frontogenesis; this scenario allows the shallow ageostrophic frontogenesis to result in deep-tropospheric ascent and enhanced precipitation in the SLRV.

Land-surface processes (NWP) / Processus de surface terrestre (NWP)

Room / Endroit (Grand salon B), Chair / Président (Stéphane Bélair), Date (01/06/2012), Time / Heure (16:30 - 18:00)

4E3.1 ID:5446 16:30

Soil moisture and terrestrial snow analyses based on the assimilation of surface-based and space-based observations in the Canadian Land Data Assimilation System

Stéphane Bélair , *Marco L. Carrera* , *Bernard Bilodeau* , *Sarah Dyck* , *Nathalie Gauthier* , *Maria Abrahamowicz* , *Sheena J. Solomon*
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Recent development work at Environment Canada (EC)'s Meteorological Research Division (MRD) has focused upon the implementation of a new Canadian Land Data Assimilation System (CaLDAS) in an effort to provide a better initialization of the land surface for the suite of EC's numerical prediction models for weather and hydrology. As part of this endeavor, both surface-based and space-based observations have been used to improve analyses of surface temperature, soil moisture, and terrestrial snow. Surface-based observations include snow depth as well as screen-level air temperature and humidity measurements. Space-based observations include L-band microwave observations from the Soil Moisture Ocean Salinity (SMOS) mission by the European Space Agency, and snow water equivalent retrievals obtained from the Advanced Microwave Scanning Radiometer – Earth Observation System (AMSR-E) and from the Special Sensor Microwave Imager (SSM/I). Several assimilation cycles have been performed in this context, and results from a few of these experiments will be presented at the conference. Comparison against independent sets of surface observations will be examined, as well as the impact of the new surface analyses on numerical weather prediction.

4E3.2 ID:5580 16:45

Winter forecasting with the Met Office Unified Model: the representation of snow cover and the stable boundary layer

John Edwards [1], *Martin Best* [1], *Gabriel Rooney* [1], *Richard Essery* [2], *Cecile Menard* [2], *Dagrun Vikhamar-Schuler* [3], *Jorn Kristiansen* [3]
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A realistic representation of snow processes is important both for hydrological modelling and for weather

and climate forecasting models. Snow processes have traditionally been represented somewhat simplistically in NWP models. Recently a new multi-layer snow scheme has been developed within the JULES community land surface model for use both in off-line modelling and in weather and climate prediction models. The scheme incorporates parametrizations of hydrology, thermodynamics and ageing within the snow pack.

In this talk we shall describe the scheme and present a preliminary analysis of its performance in the Met Office Unified Model across a range of forecasting time-scales, together with an assessment of its sensitivities to the choice of parameters. The interaction between the surface and processes in the overlying stable boundary layer will be an area of particular interest.

4E3.3 ID:5693 17:00

Snow and Ice Enhancements to the RUC Land-Surface model in WRF and WRF- based Rapid Refresh

Tatiana Smirnova [1], *John M. Brown* [2], *Stan Benjamin* [2]

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The Land Surface Model (LSM) described in this presentation was originally developed as part of the Rapid Update Cycle (RUC) model development effort at what is now the Earth System Research Laboratory (ESRL). The goal of this work was to provide more accurate lower boundary conditions for the Rapid Update Cycle (RUC). This LSM (henceforth, RUC LSM) has been operational as part of the RUC since 1998. The RUC LSM describes complicated atmosphere/land surface interactions in a simplified fashion so as to avoid excessive sensitivity in the RUC system to multiple poorly defined surface parameters. The simple parameterizations in RUC LSM have proved to be physically robust and capable of realistically reproducing evolution of soil moisture, soil temperature and snow in the cycled model, where surface fields are initialized from the previous 1-h model forecast. Our RUC LSM development has adapted some ideas from existing land surface schemes, but also conceived of some unique features which in our opinion can give more accurate representation of physical processes.

Monitoring of model performance over the years has motivated several modifications to the RUC LSM leading to better performance. Beginning in 2002, the RUC LSM became available to the WRF community as part of the yearly WRF code releases, and is implemented in the WRF-based Rapid Refresh (RAP), which will replace RUC at NCEP in March of 2012. With the much larger RAP domain covering the whole North American continent as well as large ocean areas in high latitudes, the RUC LSM needed further validation and development for application in the tundra permafrost regions and over sea ice, including heat conduction in the sea ice, and snow accumulation and ablation on top of the sea ice. The modifications to the RUC LSM were extensively tested off-line in one-dimensional framework using data from SnowMIP2 (Snow Model Intercomparison Project for forest snow processes) experiment, then were monitored and verified in the coupled developmental version of RAP, and finally were implemented in the operational RAP at NCEP. These recent modifications to ice and snow treatment in RUC LSM and results from one-dimensional and coupled RAP validations are described in this presentation.

4E3.4 ID:5448 17:15

Sub-km external surface modeling to improve numerical predictions over ecosystems, cities, and water surfaces

Stéphane Bélair , *Maria Abrahamowicz* , *Sylvie Leroyer* , *Natacha Bernier* , *Nathalie Gauthier* , *Vanh Souvanlasy* , *Alexandre Leroux* , *Jean-Philippe Gauthier*

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A so-called external land surface modeling system has been developed and tested in the last few years at Environment Canada's Meteorological Research Division (MRD) and Canadian Meteorological Centre (CMC). Called GEM-Surf, this system can be forced by either observations, atmospheric and/or surface analyses, as well as low-level forecasts from an atmospheric model. Because it is much less computationally expensive than a fully three-dimensional (3D) atmospheric model (i.e., GEM), GEM-Surf allows for relatively high-resolution integrations (in this case 200m grid spacing over Southern Ontario), taking advantage of detailed knowledge of the landscape.

The ancillary datasets used to specify physical and geometrical characteristics of the surface include Land Cover Circa 2000, the digital cartographic product CanVec, as well as Statistics Canada census for land use and land cover, for water fractional coverage, and for geometrical and thermal properties of urban areas. The datasets also include data from the Shuttle Radar Topography Mission (SRTM) for orography. The surface models integrated in GEM-Surf are the Interactions between Surface, Biosphere, and Atmosphere (ISBA) land surface scheme, the Biome-BGC (BioGeoChemistry) ecosystem model to provide vegetation characteristics such as leaf area index and vegetation conductance, and the Town Energy Balance (TEB) scheme for urban areas.

The GEM-Surf has been run in a continuous cycle mode from spring to fall 2011. Outputs from this cycle have been used as initial conditions for a series of 48-h offline surface forecasts. Objective and subjective evaluation of these runs will be presented at the conference, in view of a proposed implementation of this system at CMC.

4E3.5 ID:5803 17:30

The impact of parameter granularity of the land surface on the predictive capacity of fully distributed, physically-based models

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Land surface discretization is a fundamental step in the application of discretized, physically-based models. Geophysical properties of the land surface (e.g. soil type, vegetation, topography) are often grouped into land classification schemes, which are applied to land parcels and are input to these models. The resolution of land classification and its influence on model response has not been widely investigated.

Low-level classification (e.g. broadleaf tree vs. needle-leaf tree) or high-level classification (e.g. Douglas fir vs. Spruce) can be used in creating land classification schemes. There are a number of disadvantages to using either level of discretization. Computationally, high-level classification may introduce redundancies (e.g. different groupings that incite near-identical model response); and although the computational impact may be unimportant in simple models, the impact is evident in models that take minutes to hours to run, especially when iteration (e.g. calibration) is of concern.

"Parameter granularity" is the resolution at which geophysical parameters are lumped together to create land classification schemes. Fine-grained models may distinguish between relatively minor landscapes, while the coarsest-grained model may lump all geophysical features into a single, homogeneous aggregate. This research demonstrates the impact of parameter granularity on two fully-distributed, physically-based models: (1) the "Modélisation environnementale de la surface et de l'hydrologie" (MESH) land-surface hydrology modelling system; and (2) the Raven computational hydrology framework. Increasing parameter granularity may improve the physical-likeness of the model, but may weaken its predictive capacity by over-parameterization of land classification schemes. Decreasing the parameter granularity may improve the computational cost of the model, but may weaken its predictive capacity by providing less physically-based results.

The results have shown that parameter granularity impacts the predictive capacity of the physically-based model. They also suggest a methodology for lumping geophysical properties into an appropriate level of parameter granularity to improve modelling results.

4E3.6 ID:6179 17:45

Short-term (6 hour to 3 day) Summertime Hydrologic Ensemble Prediction

Bruce Davison [1], *Peter Yau* [2], *Vincent Fortin* [3], *Alain Pietroniro* [3], *Robert Leconte* [4], *Stéphane Belair* [3], *Daniel Kirshbaum* [2]

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Rivers are essential for life and affect human activities a great deal. Accurately predicting flows can help to manage the economic, social and environmental interests that people have in rivers. A fundamental problem with making good streamflow predictions rests with the various sources of uncertainty in modelling the flow. Ensemble modelling has the potential to account for many sources of uncertainty. The objective of this research is to improve 6 hour to 3 day hydrologic forecasts using a comprehensive hydrologic ensemble prediction system (H-EPS) which accounts for various sources of uncertainty. Preliminary results of the H-EPS will be presented for a southern Ontario watershed, followed by a discussion of the work that will be required to improve the preliminary results.

General Weather and Climate Services / Services météorologiques et climatiques en général

Room / Endroit (Grand salon C), Chair / Président (Jacinthe Lacroix), Date (01/06/2012), Time / Heure (16:30 - 18:00)

4E4.1 ID:5840 16:30

Presumed Passing of Present Weather

John Macphee

MSC - Monitoring

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In CMOS Bulletin SCMO VOL. 39, No.5, October 2011, Ken Devine wrote of the Passing of Present Weather as reported from the MSC owned automatic stations. Ken was correct in describing both the importance of present weather to the general public, and the decline of the ability of the MSC to report

present weather. However, the Atmospheric Monitoring Division (AMD) within the MSC has a plan to expand the reporting of present weather from its automated stations. As CODECON, a data processing application, is retired we are moving to a more powerful and flexible processing model. The new model, within the Data Management Framework (DMF) project, will be a phased approach to enhancing the reporting from the existing suite of sensors at the MSC Auto8 (datalogger based) stations. The talk will introduce you to the MSC Auto8 station, its present reporting protocols, and the expanded role seen for the near future. This will include multi-parameter processing (cross talk between sensors), enhanced reporting of snowfall and snow on ground, mapping to WeatherOffice Icons, mapping to CLDN data, and the possible low cost editions to the instrumentation to meet multiple data requirements.

4E4.2 ID:5333 16:45

Extensive Floods over the Canadian Prairies During the Summer of 2010 and the Associated Meteorological Conditions

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Summertime heavy rainfall can trigger severe floods over the Canadian Prairies which can become life threatening and leave huge socio-economic impacts in their wake. In the summer of 2010, the Canadian Prairies received copious amounts of rainfall leading to a large number of extreme flooding events. In this study, we describe the unique features of the flooding events in the summer of 2010 with comparison to the summer flood climatology from 2000 to 2010. A combined dataset that includes surface observation, upper air sounding, satellite, radar and lightning imagery were used to understand the extent and predictability of the precipitation that directly triggered the floods. We also examined the associated meteorological conditions that lead to the development of excessive rainfall in the summer of 2010. Detailed analysis suggested that localized convective thunderstorms, large scale synoptic weather systems and synoptic systems with embedded convection can all lead to the onset of excessive rainfall for these events. Synoptic system patterns and convective features are also illustrated in the paper to help understand and improve future forecasts for summer floods over the Canadian Prairies.

4E4.3 ID:5549 17:00

Portrait climatologique du Québec méridional

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Les changements climatiques font l’objet de nombreuses recherches, tant pour le volet de la prévision que celui de l’adaptation. Pour ce faire, l’état des connaissances sur les conditions climatiques qui prévalaient dans le passé et celles que l’on connaît aujourd’hui est de première importance. L’objectif de la présentation est de faire un survol de la température et de la précipitation du Québec telles qu’elles ont été mesurées depuis 1870.

Pour tirer profit des 141 ans de données recueillies par des observateurs aux 1013 stations climatologiques du réseau, l’équipe du Service de l’information sur le milieu atmosphérique a procédé au calcul des normales climatologiques. Les normales sont une moyenne sur 30 ans mise à jour tous les 10 ans selon les normes de fréquence de l’Organisation mondiale de la météo. Pour les données incomplètes ou manquantes, ce calcul prévoit l’estimation de celles-ci par krigeage pour l’obtention de séries les plus complètes possible. Un statut de validité est ensuite attribué à la normale qui a été calculée selon le nombre

d'années pris en compte dans les calculs.

Pour la période 1941-1970, les données recueillies dans les 130 stations ayant plus de 15 ans de données, permettent d'estimer que la normale de la température moyenne annuelle variait entre -7,0 °C (extrême nord du Québec) et 7,2 °C (île de Montréal). Alors que les 199 stations disponibles pour la période 1981-2010 varient plutôt entre -5,9 °C et 7,3 °C. De son côté, la normale (1981-2010) du cumul annuel des précipitations totales (pluie et neige) varie de 521 à 1545 millimètres avec son maximum dans la Forêt Montmorency.

Bref, même si la méthode de calcul des normales présente certaines limites d'utilisation, elle demeure un facteur d'importance dans l'établissement d'un portrait historique et actuel du climat méridional québécois.

4E4.4 ID:5808 17:15

Produits biometeorologiques au SMC-Québec: historique et bilan

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Plusieurs études ont démontré que les conditions météo peuvent affecter la santé et le bien-être mental de la population. Par exemple, Villeneuve et al (2003) a démontré que les admissions hospitalières au Canada sont fonction des conditions météorologiques. Puisque la distribution et l'intensité des variables météorologiques, allant des patrons synoptiques aux phénomènes extrêmes, risquent d'être modifiés par les changements climatiques, les clientèles cherchant assistance de la part des hôpitaux canadiens risquent également de changer. Comprendre les relations entre la santé et l'environnement atmosphérique contribuera à renforcer l'expertise en biométéorologie humaine et la capacité d'adaptation du secteur de la santé au Canada, une industrie de 70 milliards de dollars. Depuis le début des années 90, le SMC a développé et introduit plusieurs indices ou produits biométéorologiques : indice UV, avertissement de chaleur, Humidex, alerte de smog, cote air-santé, etc. La présentation fait le bilan des opérations du SMC au Québec en matière de produits biométéorologiques et un survol des autres programmes météorologiques nationaux (UK, Allemagne, France) actifs dans le domaine.

4E4.5 ID:5687 17:30

The available climatology as and added value for environmental prediction: towards the development of an operational tool

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This work was initiated in the framework a project of the Quebec's province transportation department related the adaptation and evaluation of vulnerabilities face to climate change in the Arctic environment of Nunavik. The impact of climate change on infrastructures is an important issue of this project. The objective is to develop an operational tool from the available climatology in order to enrich information for decision-making in meteorological prediction context. A conceptual framework and an integrated approach based on key climate components (atmosphere, hydrosphere, cryosphere, lithosphere) is considered. The adopted methodology is based on a GIS approach and an automatic processing algorithm. An application related to storm tracks analysis is developed within atmospheric component of the conceptual framework. The considered data set include a North American storm climatology from reanalyses and several model data (historical and future projection) in terms of variables and intensity, duration and frequency indices. Some

processing results and the potential of the operational tool for decision support for several application fields in particular forecast system is outlined.

4E4.6 ID:5558 17:45

Instrumentation du Programme de surveillance du climat et bilan climatologique 2011 au Québec

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Le Programme de surveillance du climat (PSC) du ministère du Développement durable, de l'Environnement et des Parcs est le plus important réseau de stations météorologiques et climatologiques au Québec. Son historique de données débute en 1870. Principalement localisé dans le Québec méridional, il compte plus de 280 stations avec observateur (aussi équipées d'instruments automatiques) et près de 80 stations entièrement automatiques. Le PSC comporte aussi un réseau complémentaire d'une centaine de stations nivométriques qui permettent de déterminer les quantités d'eau emmagasinées dans le couvert nival, une information cruciale, entre autres pour les besoins de sécurité publique lors de la fonte des neiges.

En première partie de la présentation, l'instrumentation et les méthodes de mesure utilisées dans ces trois types de stations ainsi que les moyens de transmission des données recueillies permettant un archivage et une validation rapides sont sommairement abordés. Le portrait est complété par une brève description des méthodes de validation de données utilisées au PSC.

La deuxième partie est consacrée à la présentation du bilan climatologique (température, précipitation, degrés-jours, etc.) de l'année 2011 et de l'hiver 2011 2012 en le comparant aux normales 1981-2010. Quelques-uns des évènements météorologiques marquants de cette période seront aussi décrits.

Ecosystem-Based Oceanography / Océanographie relative aux écosystèmes

Room / Endroit (Symphonie 1), Chair / Président (Laura Bianucci), Date (01/06/2012), Time / Heure (16:30 - 18:00)

4E5.1 ID:5911 16:30

Operational Oceanography: the way ahead in ecosystems-based context

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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 highlight the importance of operational oceanography within Fisheries and Oceans Canada (DFO) and the

Department’s renewed efforts and focus on operational oceanography will continue to reflect the needs of clients. One goal is the management of ocean ecosystems based on integrated overviews provided in near to real time, updated frequently and linked clearly to ecosystem characteristics of interest. There are several advances in operational oceanography that are poised to move ecosystem-based ocean management into a new and more credible position.

4E5.2 ID:5915 16:45

An Ecosystem Approach to Management: Designing Science Programs to Meet Management Needs

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Within the Canadian context, various Federal departments (including Fisheries and Oceans Canada, DFO) have indicated an intention to adopt an ecosystem approach to management to fulfil their respective mandates. An ecosystem approach is generally accepted to be an adaptive approach to managing human activities in a geographically specific area, while taking into account both ecosystem knowledge and uncertainties, and in consideration of multiple external influences and stressors on the environment. Precisely how this will be implemented still under development. What is certain is that new science support will be requested, designed to support specific management needs for policy development and pending regulatory decisions. Operational demands for targeted science will likely include science support for the development of standards and thresholds to be applied at the ecosystem scale; support for defining the scope and scale of this management approach, and providing scientific tools for decision-making and policy development at the ecosystem scale (e.g. risk assessment). This presentation will discuss the likely paradigm shift in the management of aquatic resources, and the ways in which science programs can adapt to help meet these evolving management needs.

4E5.3 ID:5605 17:00

A risk-based approach to managing the impacts of climate change on Canada’s aquatic resources and ecosystems

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Risk is the combination of the probability of a hazardous event occurring, and the impact or consequence of that event. Climate Change poses a risk to Canadian aquatic resources and ecosystems, and hence the ability of Fisheries and Oceans Canada to deliver on its mandate. The 2005 National Climate Change Risk Assessment identified risks to ecosystems and fisheries as well as those associated with safety and accessibility of waterways. In order to build institutional resilience to climate change, risks need to be assessed and findings integrated with programming. The Department’s Aquatic Climate Change Adaptation Services Program’s risk-based approach seeks to assess impacts and vulnerabilities based on projected future states of Canada’s aquatic resources; the assessment framework includes socio-economic considerations. Initial actions focus on four large aquatic basins, consisting of Canada’s three oceans and its inland waters. This process will identify vulnerable regions within the large aquatic basins for further study, and establish priorities in research and adaptation-tool development.

4E5.4 ID:5440 17:15

Continuous Acoustic Monitoring of Zooplankton Biomass on the West Coast of Vancouver Island

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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 2 Tb of data. We have tried to separate fish and zooplankton in the acoustic record with a simple multi-frequency classification scheme, and used the scattering volume strength of the apparent zooplankton signal to form bulk estimates of zooplankton biomass. At the same time, monthly zooplankton net tows near the sounder have been analyzed for wet mass and species composition in several size classes. These direct observations are correlated with the acoustic record, and seem to show some similarity, but interpretation is difficult because the acoustic record shows large variations at time scales much shorter than the interval between net tows.

4E5.5 ID:5622 17:30

Hypoxia in the Strait of Georgia

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The Strait of Georgia does not suffer from coastal eutrophication. This makes it different from many coastal seas, including the neighbouring Puget Sound and the St. Lawrence estuary on the east coast. Nonetheless, the concentration of oxygen in the deep water of the Strait of Georgia is declining. About a quarter of the decline can be explained by decreased oxygen solubility due to the warming of seawater. The remainder relates to changes in the upwelled Pacific Ocean water that renews the bottom water of the Strait annually, and, possibly, to changes in local organic carbon cycling. Variability on the timescale of days, superimposed on the long-term trend, causes the concentration of oxygen in the deep Strait of Georgia to dip below 2.2 mL/L several times a year. The basin average oxidation rate of organic carbon of 40 $gCm^{-2}yr^{-1}$ implies an in situ drawdown of about 0.7 mL/L of oxygen each year, which is replaced during deep-water renewal. Even in the absence of local eutrophication, declining oxygen in the inflowing water from the Pacific Ocean leaves the ecosystem of the deep Strait of Georgia vulnerable to seasonal hypoxia.

4E5.6 ID:5910 17:45

Satellite Data and Ecosystem-Based Management

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Working with the Canadian Space Agency, Fisheries and Oceans Canada (DFO) has developed a variety of new data products based on satellite data to support ecosystem-based management. There remains enormous potential to expand and operationalise the use of satellite data, including ocean colour by: developing operational models relating phytoplankton phenology to ocean physics for fisheries applications; developing innovative earth-observation (EO) products for monitoring oceanic and inshore waters; and delivering web-based access to sea surface temperature (SST) and ocean colour data and derived products for all Canadian waters. This paper will assess the current state of ecosystem-related ocean products and identify future needed developments, including the transition of ecological indicators to the operational domain; improved ecosystem models, and enhanced linkages between ocean colour scientists and ecological experts.