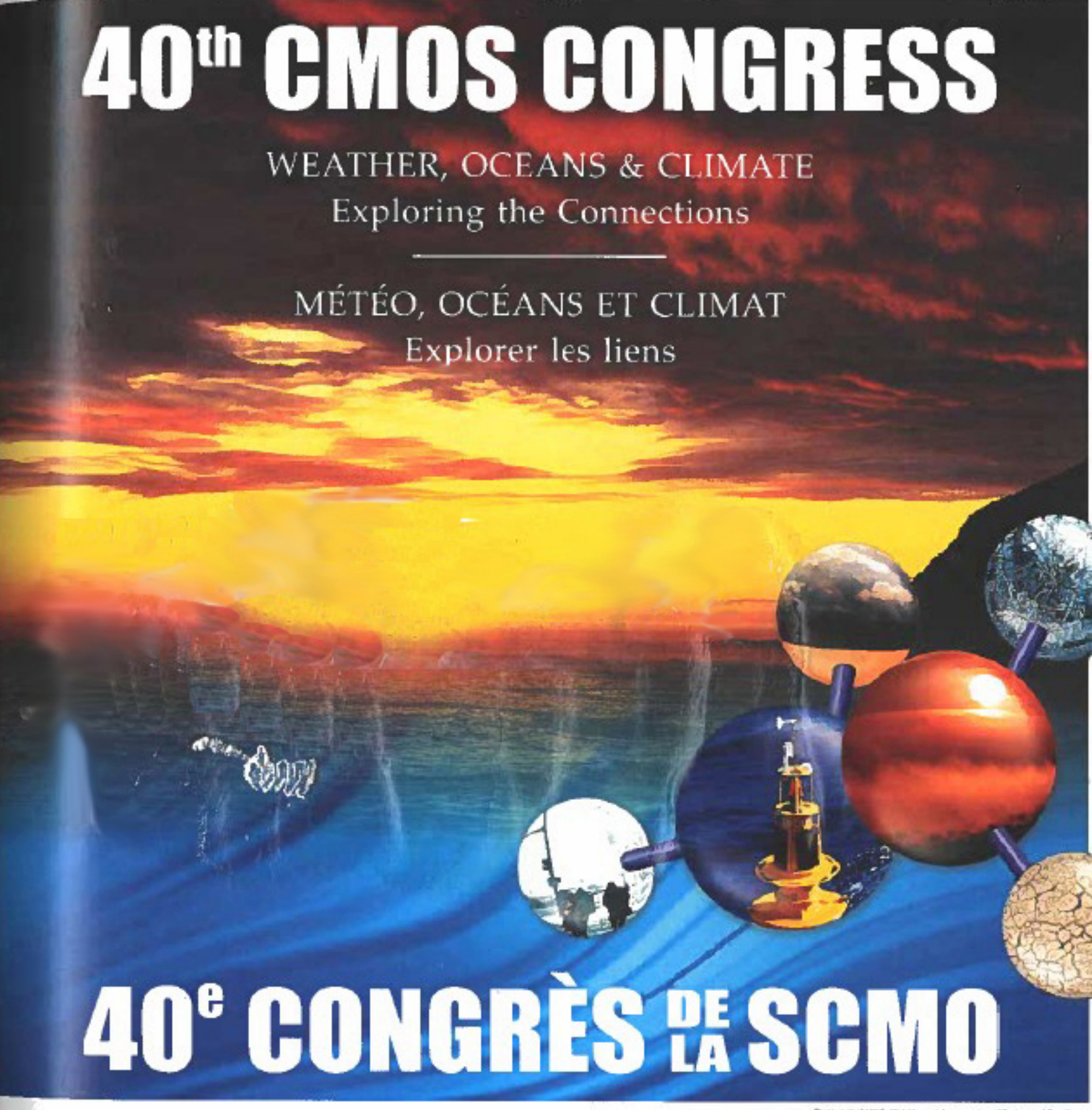
40th CMOS CONGRESS

WEATHER, OCEANS & CLIMATE
Exploring the Connections

MÉTÉO, OCÉANS ET CLIMAT
Explorer les liens



40e CONGRÈS DE LA SCMO

Photograph of AZYS «WatchKeeper» buoy, courtesy of Environment Canada
Photo de la bouée AXYS «WatchKeeper», gracieuseté d'Environnement Canada

Toronto, Ontario
29 May/mai - 1 June/juin, 2006

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

web : **www.cmos2006.ca**
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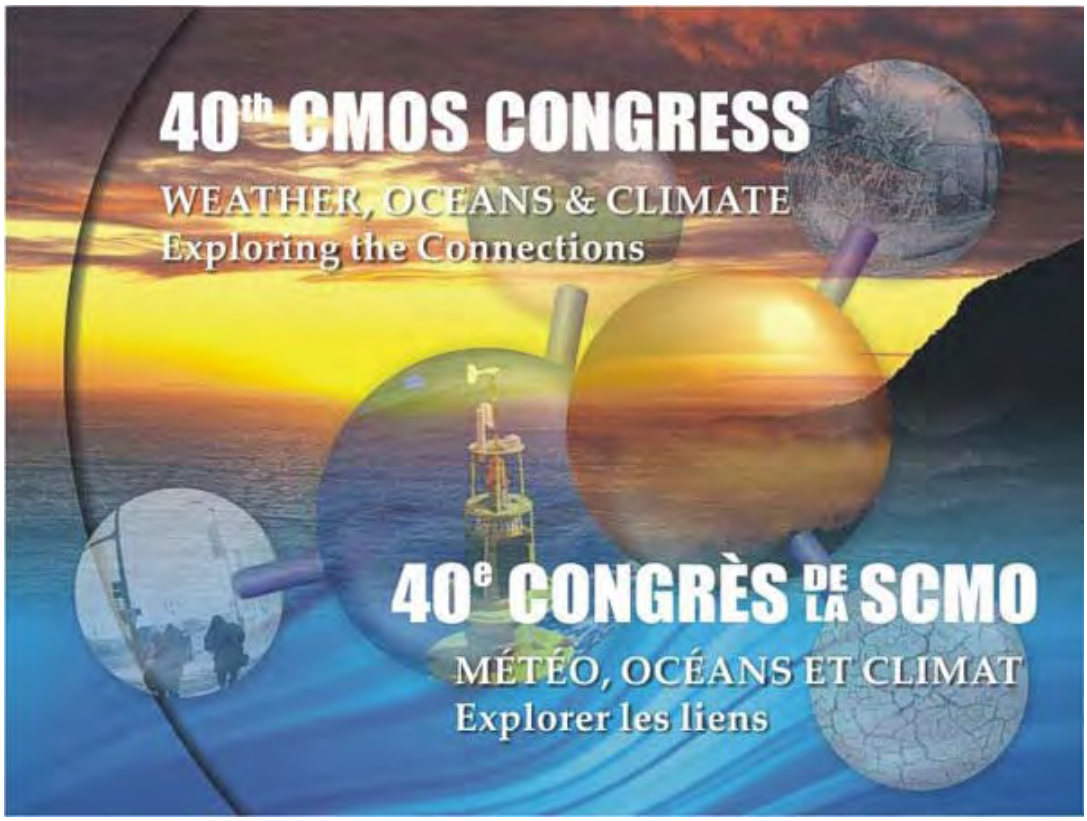

Welcome

Whether this is your first, fifth or even 40th CMOS Congress, it is hoped that it will be a truly memorable one for you. With over 450 oral and poster presentations, it promises to be a very stimulating scientific program covering our Society's broad spectrum of interests. There is also a busy schedule of associated meetings and enjoyable evening events, including our Annual General Meeting. The Congress provides us with an excellent opportunity to gather together to share our scientific advances, to recognize our outstanding colleagues through a variety of prizes and awards, to celebrate together, to conduct important business in the evolution of CMOS, to renew old friendships and to make new ones.

Each year a new team of dedicated CMOS members dedicates hundreds of hours of volunteer time to planning and running the Congress. We are indebted to this year's team from Toronto led by Local Arrangements Chair, David Hudak, and Scientific Program Committee Chair, Paul Kushner. I would like to thank Dave, Paul and all the volunteers from Toronto for being our hosts this year. In addition, the staff of the National Office dedicates an extraordinary amount of time to processing the abstracts and registrations. I would like to extend my thanks to our Executive Director, Ian Rutherford, and his conscientious team.

On behalf of CMOS, it is my pleasure to welcome you to our 40 th Annual Congress. Best wishes to all for an exciting and productive meeting in Toronto.

Susan Woodbury
President, CMOS
2005-2006

Bienvenue

Qu'il s'agisse de votre premier, cinquième ou même 40e congrès de la SCMO, nous espérons qu'il sera vraiment mémorable pour vous. Avec plus de 450 présentations orales et par affiches, le programme scientifique promet d'être très stimulant, couvrant la large gamme des intérêts de notre Société. L'horaire est bien rempli, notamment de rencontres associées et d'agréables événements en soirée, incluant notre assemblée générale annuelle. Le congrès nous fournit une excellente occasion de nous rassembler pour partager nos avancées scientifiques, de reconnaître le travail de nos éminents collègues grâce à une variété de prix et récompenses, de célébrer ensemble, de mener d'importantes affaires pour l'évolution de la SCMO, de renouer avec d'anciennes amitiés et d'en faire naître de nouvelles.

Chaque année une nouvelle équipe de membres dévoués de la SCMO consacre des centaines d'heures de bénévolat à la planification et la bonne marche du congrès. Nous sommes redevables cette année à l'équipe de Toronto dirigée par David Hudak, président des arrangements locaux et Paul Kushner, président du comité de la programmation scientifique. J'aimerais remercier Dave, Paul et tous les bénévoles de l'organisation pour leur accueil cette année. De plus, le personnel du Bureau national consacre énormément de temps à traiter les résumés et les inscriptions. J'aimerais également remercier notre directeur exécutif, Ian Rutherford, et son équipe consciencieuse.

Au nom de la SCMO, permettez-moi de vous souhaiter la bienvenue à notre 40e congrès à Toronto. J'espère que ce congrès sera pour vous excitant et productif!

Susan Woodbury
Présidente, SCMO
2005-2006

A Word about the Society

The Canadian Meteorological Society was formed in 1967 from a branch of the Royal Meteorological Society that dates back to 1939. In 1977 when the oceanographic community joined, the name of the Society was changed to the Canadian Meteorological and Oceanographic Society (CMOS). The Society was subsequently incorporated with this name in 1984.

CMOS is a national society of individuals dedicated to advancing all aspects of atmospheric sciences, oceanography, and related disciplines in Canada. The Society also offers accreditation of meteorological consultants and endorsement of media weathercasters. Fourteen Centres across Canada serve as focal points for local and regional activities.

Scientific interests of the Society include: all aspects of meteorology, climatology, hydrology, air pollution, agriculture/forestry meteorology, floating ice, physical, chemical and fisheries oceanography.

The Society offers travel bursaries for students to attend Annual Congresses, a secondary school teacher travel bursary for the AMS/NOAA Workshop "Project Atmosphere", the Weather Research House/CMOS/NSERC graduate student supplementary scholarship, undergraduate scholarships, the Campbell Scientific prize for the best poster presentation at a Congress, the CMOS Weather Network Scholarship and the Roger Daley Postdoctoral Publication Award.

The main publications of CMOS are the bimonthly CMOS Bulletin SCMO and ATMOSPHERE-OCEAN (A-O), a quarterly refereed journal for the publication of results of original research.

The Society also maintains an electronic Web site with information on the Society and its activities pertaining to meteorological and oceanographic activities across Canada. There is a special section devoted to the Private Sector where companies and services are now listed.

There is a "Members Only" section on the Web site for updating of addresses and preferences, renewing membership, consulting a directory of members, registering and submitting abstracts to meetings, and viewing the Bulletin and Annual Review on line.

For additional information visit the CMOS web site at: **http://www.cmos.ca**

Quelques mots à propos de la Société

La Société canadienne de météorologie a été formée en 1967, à partir d'un chapitre de la Royal Meteorological Society, établi en 1939. Lorsque les océanographes s'y sont joints en 1977, le nom de la Société est devenu Société canadienne de météorologie et d'océanographie. La Société fut incorporée sous ce nom en 1984.

La SCMO est une organisation nationale regroupant des individus voués à la promotion au Canada de la météorologie et de l'océanographie, ainsi que des disciplines environnementales connexes, sous tous leurs aspects. La Société offre aussi la certification d'experts-conseils en météorologie et l'agrémentation des présentateurs météo. Quatorze centres locaux sont les pivots des activités locales et régionales.

Les intérêts scientifiques de la Société incluent: tous les aspects de la météorologie, la climatologie, l'hydrologie, la pollution de l'air, la météorologie agricole et forestière, la mésométéorologie, les glaces flottantes et l'océanographie chimique, physique et halieutique.

La Société offre des bourses de voyages à des étudiants pour assister au congrès annuel, une bourse de voyage à un enseignant pour l'atelier "Project

Atmosphere" de l'AMS/NOAA, la bourse de troisième cycle "Weather Research House/SCMO/CRSNG, des bourse aux étudiants sous gradués, le Prix Campbell Scientific pour la meilleure présentation sur poster, la bourse SCMO/MétéoMédia, et depuis peu, la bourse pour publication post doctoral Roger Daley.

Les principales publications de la Société sont le CMOS Bulletin SCMO bimestriel et ATMOSPHERE-OCÉAN (A-O), une revue scientifique trimestrielle qui présente des articles, préalablement soumis à la critique, sur les résultats de recherches originales.

La SCMO a aussi une page d'accueil sur son site WEB où on trouve de l'information générale sur la SCMO et ses activités, ainsi que sur la science et l'enseignement de la météorologie et de l'océanographie au Canada. Il y a une section dévouée au secteur privé où on énumère les compagnies et leurs services.

Une section du site web est réservée aux membres seulement. Les membres peuvent ainsi mettre à jour leur adresse et préférences, renouveler leur adhésion, consulter le répertoire des membres, s'inscrire aux réunions et y soumettre des résumés, ainsi que consulter le Bulletin et la Revue Annuelle, en ligne.

On trouvera plus d'information sur la SCMO à **http://www.scmo.ca**

Welcome from the Chairs of CMOS 2006

Welcome from the Chairs of CMOS 2006

On behalf of the Canadian Meteorological and Oceanographic Society, the hard-working members of the Local Arrangements and Scientific Program Committees, and the CMOS office in Ottawa, we welcome you to the 2006 CMOS Congress in Toronto. The annual congress is the foremost venue in Canada for the interchange of ideas by the government, academic, and private sector oceanographic and meteorological communities. It is a great place to catch up on what is happening in Canada and abroad.

For the first time we have produced a CD-ROM with the abstracts instead of placing the abstracts in the congress book. We feel that the CD-ROM is more portable and environmentally friendly than a large book of abstracts, and will be a better keepsake of the Congress. We hope you like the change.

This year's science programme features over a dozen science sessions on a wide range of topics in the atmospheric, ocean and climate sciences. We hope you find worthwhile the mix of topics and the emphasis on both high-quality oral and poster sessions. We invite you, in the words of our theme, to “Explore the Connections” and sample sessions that lie outside your specialization. Don't forget about the new events of this year's congress, including the Young Scientists Forum on Monday May 29 and the CMOS Public Lecture on Tuesday May 30.

Members of the LAC are prominently identified by their badges. Feel free to contact any of us if you have concerns or requirements that need attention.

Finally, please set aside some time to enjoy our fair city with your friends and colleagues.

Paul Kushner, Chair, CMOS2006 Scientific Program Committee

David Hudak, Chair, CMOS2006 Local Arrangements Committee

Mot de bienvenue des présidents de la SCMO 2006

Bienvenue de la part des présidents du congr è s de la SCMO 2006

Au nom de la Société canadienne d'océanographie et de météorologie, des membres du comité organisateur et du comité du programme scientifique ainsi que du bureau de la SCMO à Ottawa, nous vous souhaitons la bienvenue au Congrès 2006 de la SCMO à Toronto. Le congrès annuel est un des lieux d'échange les plus importants au Canada entre le gouvernement, la communauté universitaire et le secteur privé en océanographie et en météorologie. Le congrès est l'occasion idéale de vous mettre à jour sur ce qui se fait ici et ailleurs dans le monde dans ces domaines.

Cette année, nous avons décidé de réunir les résumés sur un CD-ROM plutôt que de les publier dans l'annuaire du congrès. Le CD-ROM nous semble plus pratique et écologique qu'un gros recueil de résumés et fera un meilleur souvenir du Congrès. Nous espérons que vous apprécierez le changement.

Cette année, le programme scientifique comporte plus d'une douzaine de sessions scientifiques portant sur une variété de sujets en science de l'atmosphère, en océanographie et en climatologie. Nous espérons que les différents sujets de même que l'importance accordée aussi bien aux sessions orales qu'aux sessions par affiches susciteront votre intérêt. Pour reprendre le

thème de cette année, nous vous invitons à « explorer les liens » et à assister aux sessions qui ne font pas nécessairement partie de votre domaine de spécialité. N'oubliez pas les nouveaux événements du congrès de cette année, soit le Forum des jeunes scientifiques, le lundi 29 mai et la conférence grand public, le mardi 30 mai.

Tous les membres du comité organisateur arboreront un insigne distinctif. N'hésitez pas à nous faire connaître vos préoccupations ou vos exigences s'il y a lieu.

Et surtout, gardez-vous du temps pour visiter notre belle ville avec vos amis et collègues.

Paul Kushner, président du comité du programme scientifique de la SCMO 2006

David Hudak, président du comité organisateur de la SCMO 2006

Toronto CMOS Local Arrangements Committee / Comité organisateur de la SCMO de Toronto

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Dawn McDonald	Media Sub-Committee	Sous-comité des médias
Jack Saunders	Media Sub-Committee	Sous-comité des médias
Angus Fergusson	Publications Sub-Committee	Sous-comité des publications
Nick Czernkovich	Publications Sub-Committee	Sous-comité des publications
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Rebecca Wagner	Sponsorship Sub-Committee	Sous-comités des commandites
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Dave Steenbergen	Advertising Coordinator	Coordonnateur de la publicité
Georgiana Chung	Graphics Coordinator	Coordonnatrice du graphisme

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1	CMOS	Ian Rutherford	613-990-0300
2	CFCAS	Elizabeth Doyle	613-238-2223x209
3	Info-Electonics Systems Inc.	Wendy Borsuk	514-421-0767x229
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5	EC (Ottawa)	Denis Simard	819-994-7499
6	COMET	Elizabeth Lessard	303-497-8344
7	EC-Severe Weather Research	Norbert Driedger	905-833-3905x241
8	Content Interface Corp.	My Le	416-736-7006
9	MetOcean Data Systems	Emily MacPherson	902-468-2505
10	Aquatic Informatics Inc.	Natalie Sheh	604-873-2782
11	AXYS Technologies Inc.	Natasha Dilay	250-655-5860
12	Recherche en Prevision Numerique	Wei Yu	514-421-4773
13	CMOS 2007	Cathy Hogan	709-738-7059
14	Canadian Ice Service	Guy Stogaitis	613-947-1867
15	Hoskin Scientific LTD.	Derek McKeown	905-333-5510
16	Campbell Scientific	Carl deLeeuw	780-454-2506

Floor Plan


CMOS 2006
EXHIBITS
FLOOR PLAN
Plenary Room
Community Meetings
Breakout 1
Breakout 2
ESCALATORS
THE SHERATON CENTRE
LOWER CONCOURSE
GRAND BALLROOM
& SHERATON HALL
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7

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Click on the column header to sort results by that item

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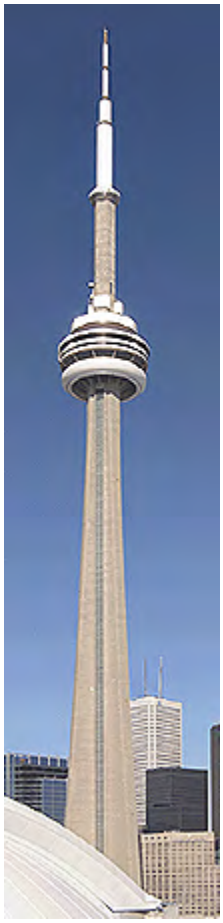
General Local Information



There are several websites with a lot of local information about Toronto:

www.toronto.ca - Toronto's 'official' website. Includes the Toronto Transit Commission (TTC) website

www.toronto.com - info about events, movies, theatre, restaurants, hotels, shopping, dining, etc.

www.torontotourism.com - hotel info, vistor services, tours, the 'official' tourism website

For restaurant information in particular, there are two sites that have links to restaurants that have their menus online, but be aware many smaller restaurants are not listed.

www.menupalace.com
www.menu101.com

Maps

- Toronto GTA Map
- Downtown Visitors Map
- Complete TTC Map
- Downtown TTC Map
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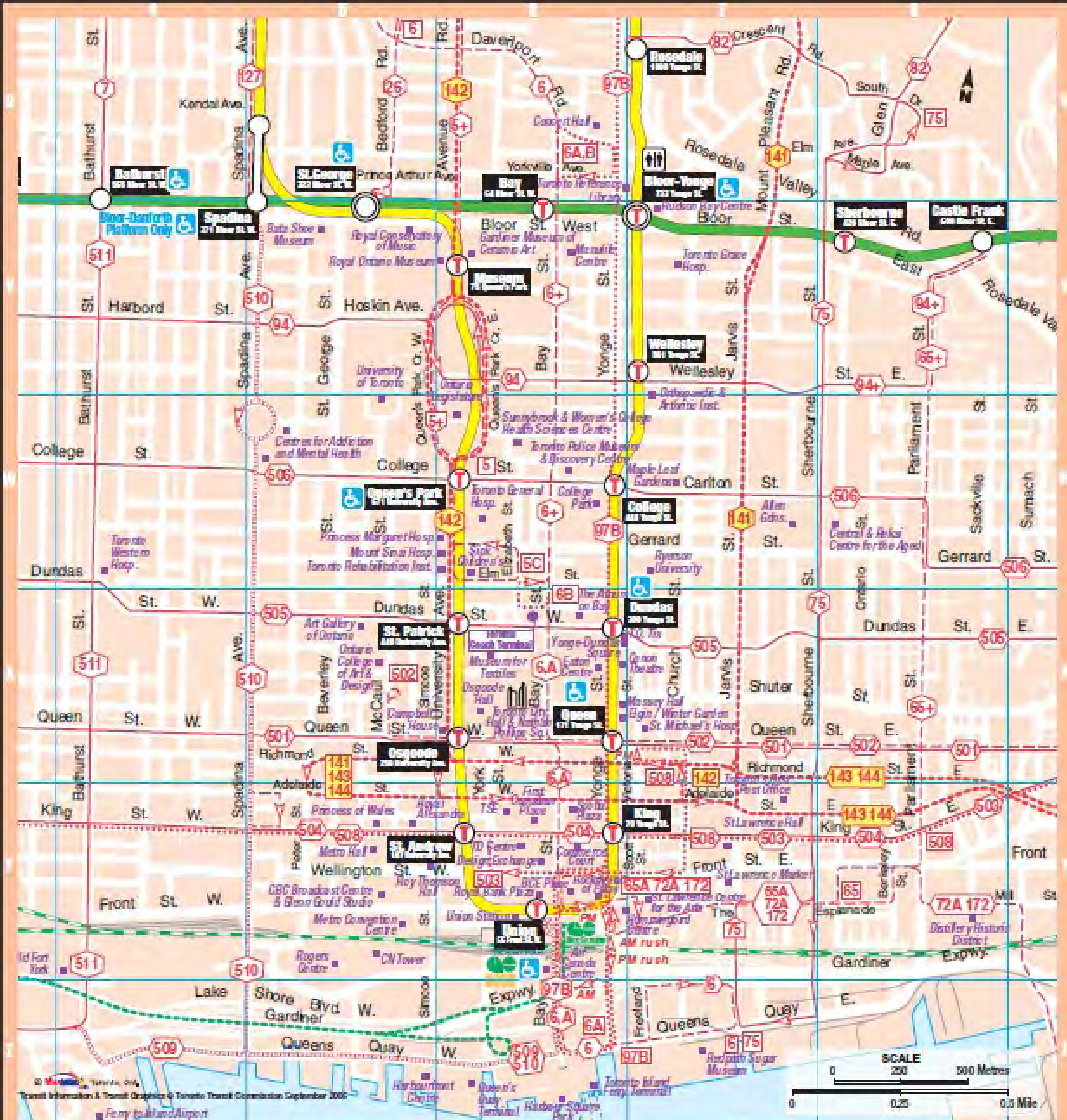

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College Park
Allen Gdns.
Princess Margaret Hosp.
Mount Sinai Hosp.
Toronto Rehabilitation Inst.
Sick Children's
Toronto Western Hosp.
Ryerson University
The Atrium on Bay
Art Gallery of Ontario
Ontario College of Art & Design
Museum for Textiles
Eaton Centre
Massey Hall
Elgin / Winter Garden
St. Michael's Hosp.
Campbell House
Toronto City Hall & Nathan Phillips Sq.
Princess of Wales
Royal Alexandra
TSE
First Canadian Place
Metro Hall
TD Centre
Design Exchange
Commerce Court
CBC Broadcast Centre & Glenn Gould Studio
Roy Thomson Hall
Royal Bank Plaza
BCE Place
St. Lawrence Centre for the Arts
St. Lawrence Hall
St. Lawrence Market
Metro Convention Centre
Union Station
Air Canada Centre
Rogers Centre
CN Tower
Distillery Historic District
Redpath Sugar Museum
Harbourfront Centre
Queen's Quay Terminal
Toronto Island Ferry Terminal
Ferry to Island Airport
Esplanade
SCALE
500 Metres
0.5 Mile
Transit Information & Transit Graphics © Toronto Transit Commission September 2006

Yonge-University-Spadina Subway

Bloor-Danforth Subway

Transfer required for connecting routes

Accessible Station

Regular Surface Routes (Bus, streetcar) Approx. 18-20 hours every day.

Streetcar Rapid Transit

Express Surface Routes

Rush Hour Surface Routes Monday to Friday rush hours only from approx. 6:00-9:00am and 3:00-6:00pm.

Limited Service Surface Routes Service less than 18-20 hours every day, usually Monday to Friday from approx. 6:00am to 7:00pm with some evening and/or weekend service.

A rectangular box indicates the end point of a line.

A pointed box is angled to indicate the direction of travel.

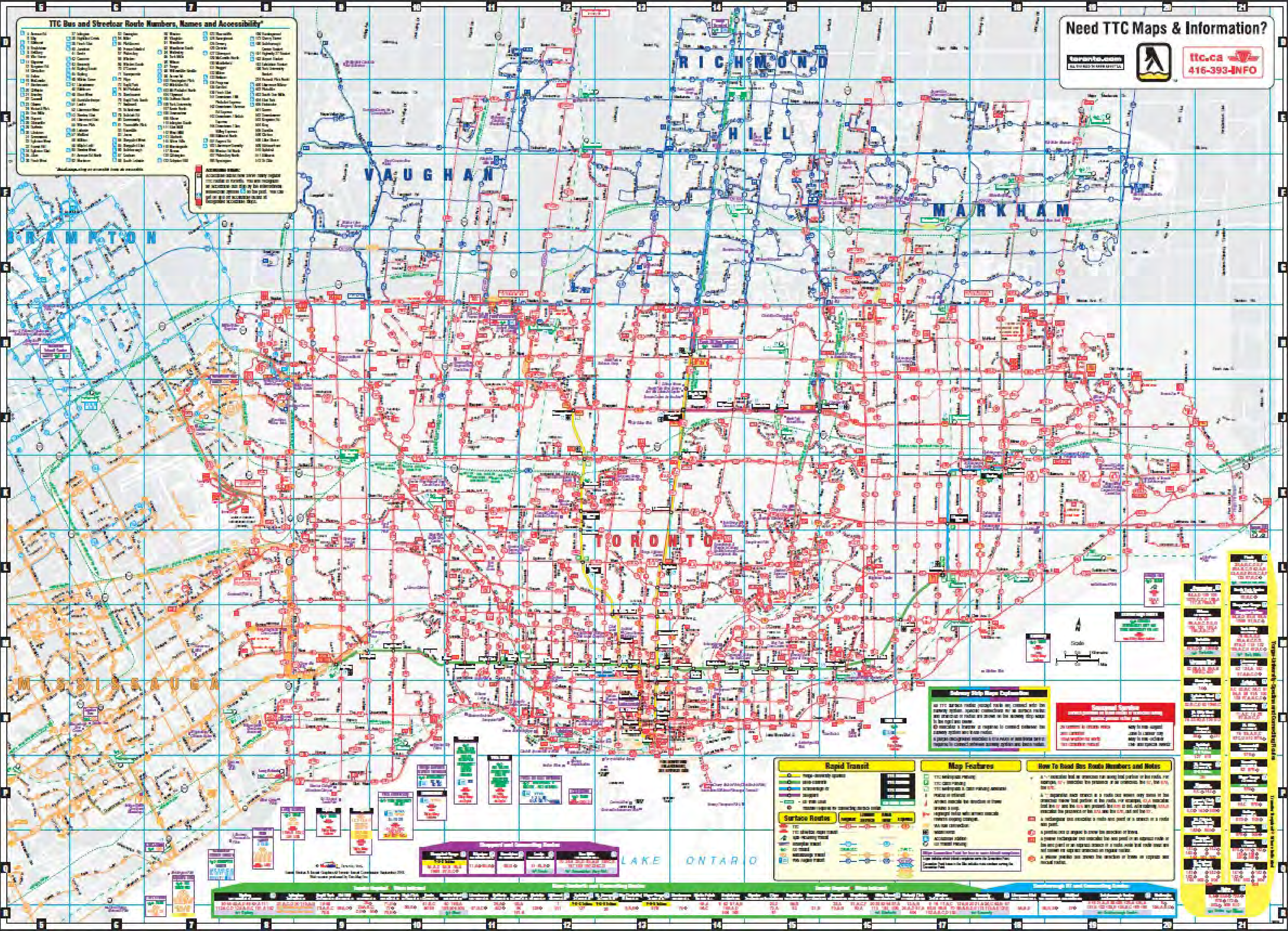
Arrows indicate the direction of travel around a loop.

A plus indicates that all route branches run along that portion of the route.

GO Rail Lines

GO Bus Routes

Place of Interest


TTC Bus and Streetcar Route Numbers, Names and Accessibility*
Need TTC Maps & Information?
ttc.ca
416-393-INFO
RICHMOND HILL
VAUGHAN
MARKHAM
BRAMPTON
TORONTO
MISSISSAUGA
LAKE ONTARIO
Rapid Transit
Map Features
How To Read Bus Route Numbers and Notes
Surface Routes

Legend

1. Visitor Information
2. Allan Gardens Conservatory
3. Air Canada Centre
4. Art Gallery of Ontario
5. Bata Shoe Museum
6. Bus Terminal
7. Canon Theatre
8. CBC Broadcast Centre
9. City Hall, Nathan Phillips Square
10. CityTV
11. CN Tower
12. Design Exchange
13. Distillery District
14. Dundas Square
15. Elgin & Winter Garden Theatre
16. Fort York
17. Gardiner Museum of Ceramic Art
18. Harbourfront Centre
19. Hockey Hall of Fame
20. Hummingbird Theatre
21. Kensington Market
22. Mackenzie House
23. Massey Hall
24. Metro Toronto Convention Centre
25. Music Garden
26. Olympic Spirit Centre
27. Princess of Wales Theatre
28. Roy Thomson Hall
29. Royal AlexandraTheatre
30. Royal Ontario Museum
31. Second City
32. SkyDome
33. St. Lawrence Centre
34. St. Lawrence Market
35. Textile Museum
36. T.O. Tix
37. Toronto Island Ferry Terminal

Legend

1. Black Creek Pioneer Village
2. Casa Loma
3. Colborne Lodge
4. Exhibition Place & NTC
5. Fort York
6. Gibson House Museum
7. Montgomery's Inn
8. Ontario Place
9. Ontario Science Centre
10. Scarborough Historical Museum
11. Spadina Historic House and Gardens
12. Todmorden Mills Museum
13. Toronto Centre for the Arts
14. Toronto Aerospace Museum
15. Toronto Zoo
16. Union Station
17. Woodbine Race Track & Slots

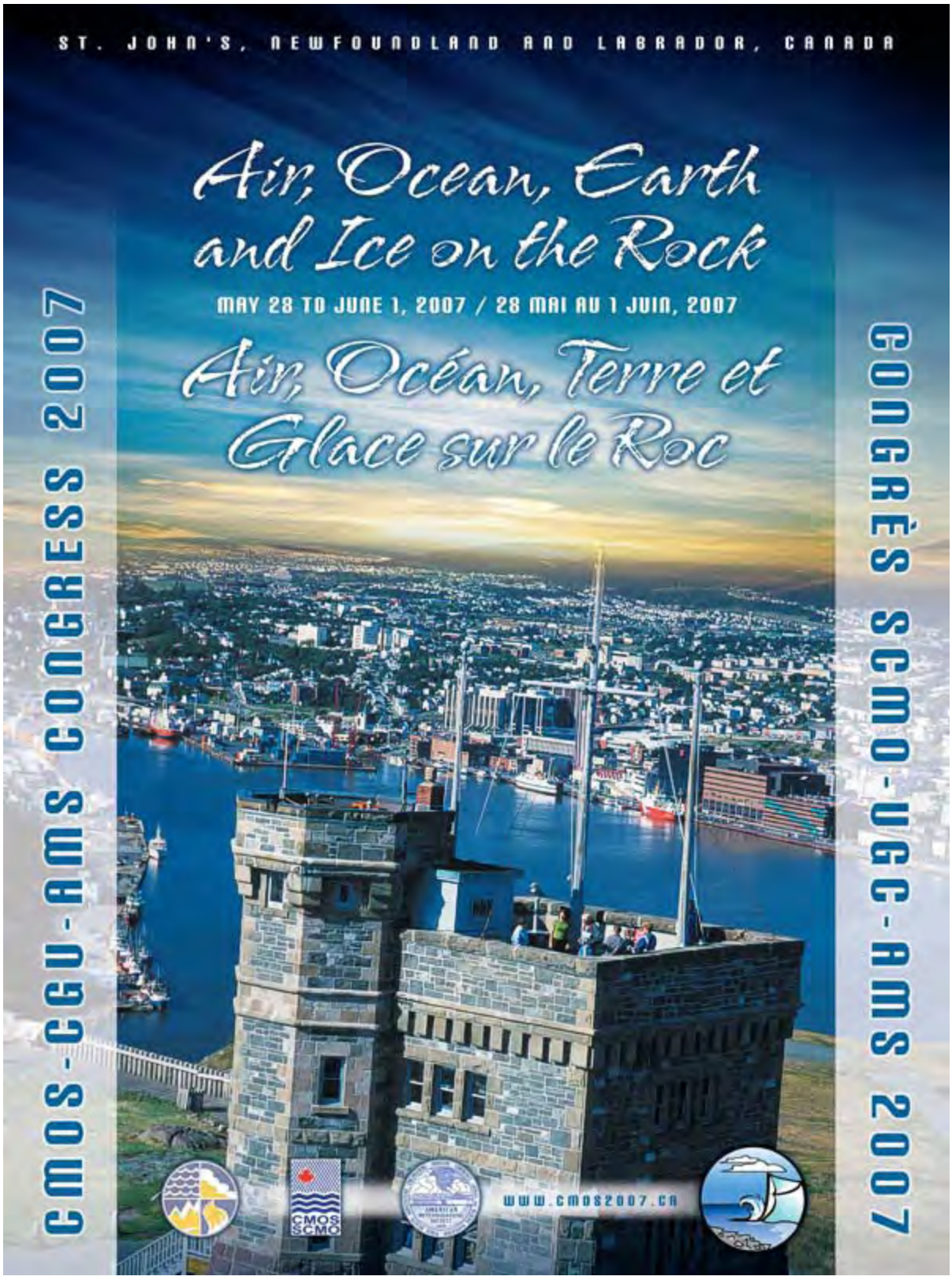
Toronto – useful numbers

Emergency **911**
Travellers Aid **416-366-7788**
Tourism Toronto . . . **416-203-2600**

For non-emergency medical assistance, see "HOSPITALS" in the business listings of the telephone directory.
For non-emergency police assistance (reporting a crime or accident, etc.) call 416-808-2222.

Consulates:
American 416-595-1700
British 416-593-1267
French 416-925-8041
German. 416-925-2813
Italian 416-977-1566
or look under "CONSULATE GENERAL" in the telephone directory.

Transportation:
Airport Express – Pacific Western . . 905-564-3232
Pearson, Terminals 1 and 2 416-247-7678
Pearson, Terminal 3 416-776-5100
Toronto City Centre Airport. 416-203-6942
Toronto Island Ferry 416-392-8193
Greyhound bus service 416-367-8747
VIA Rail. 416-366-8411
Ferry to Rochester "The Breeze" 1-877-825-3774


ST. JOHN'S, NEWFOUNDLAND AND LABRADOR, CANADA
Air, Ocean, Earth and Ice on the Rock
MAY 28 TO JUNE 1, 2007 / 28 MAI AU 1 JUIN, 2007
Air, Océan, Terre et Glace sur le Roc
CMOS-CGU-AMS CONGRESS 2007
CONGRÈS SCMO-UGC-AMS 2007
CMOS SCMO
www.cmos2007.ca

Science Programme

A1 - Warnings and Technology in Weather Forecasting

Convenor:

- **Pat King, Environment Canada**

Description:

Papers are solicited in all aspects of weather analysis and forecasting. In particular, we invite papers concerned with delivering warnings in severe and high impact weather in an era of burgeoning technology and new data sources.

A2 - Remote Sensing of the Atmosphere and Surface from Space

Convenor:

- **Kaley Walker, University of Waterloo**

Invited:

- **Alexander Trichtchenko, Natural Resources Canada**
- **Solène Turquety, CNRS**

Description:

Space-based observations provide a unique global perspective on the Earth's atmosphere and surface, including the land, vegetation, ice, snow, and oceans. Current and planned satellite missions, such as Terra, Odin, Envisat, ACE, Aqua, Aura, CloudSat, and GPM, promise a wealth of new information that can be used to investigate a wide range of scientific questions. This session encourages contributions dealing with the many facets of space-based remote sensing, including new measurement technologies and techniques, both passive and active; retrieval algorithms; validation of satellite products; assimilation of data into numerical models; and scientific results and discoveries.

A3 - Arctic Weather and Climate Studies : A Challenge for IPY

Convenor:

- **Ron Stewart, McGill University.**

Invited:

- **Michel Béland**

Description:

The Arctic is characterized by many severe weather events and an extreme and changing climate with significant regional variations. Some research has been conducted on these features but much more is needed before we can reliably anticipate weather events and long-term climate trends, and respond in a responsible, sustainable manner. One of the major stumbling blocks for research on these topics has been the paucity of observational information and the lack of coordination between individual studies. The 2007-08 International Polar Year (IPY) serves as an excellent means of advancing Arctic weather and climate studies because it will act as a unique facilitating and coordinating activity. In this CMOS session, submissions are requested from all branches of atmospheric, oceanic, cryospheric and land surface science that focus on Arctic weather and climate and that will benefit from and contribute to IPY.

A4 - Carbon Cycle: Measurement and Biosphere-Atmosphere Interactions

Convenor:

- **Dylan Jones, University of Toronto**
- **John Lin, University of Waterloo**

Invited:

- **Jing Chen, University of Toronto**
- **Larry Flanagan, University of Lethbridge**

Description:

The biosphere plays a critical role in determining the carbon budget of the atmosphere. Improving our understanding of recent changes in the atmospheric abundance of CO2 will require a better description of the processes controlling the exchange of carbon between the biosphere and atmosphere. This session invites contributions from modelling studies and measurement programs focused on quantifying terrestrial sources and sinks of atmospheric CO2, and on providing an improved representation of the processes driving the biosphere-atmosphere exchange of carbon.

A5 - Stratospheric Processes and their Role in Climate

Convenor:

- **Norm McFarlane, Environment Canada**

Invited:

- **Peter Haynes, University of Cambridge**
- **Bill Randel, NCAR**
- **Ian Folkins, Dalhousie University**
- **Saroja Polavarapu, Environment Canada**
- **Ted Shepherd, University of Toronto**

Description:

This session will focus on topics falling within the scope of the WCRP SPARC (Stratospheric Processes and their Role in Climate) program. Accordingly, it will encompass the chemistry and dynamics of the atmosphere from the upper troposphere to the mesosphere, with an emphasis on integrative or coupled

aspects. The over-arching themes of SPARC are chemistry-climate coupling; stratosphere-troposphere dynamical coupling; and the detection, attribution and prediction of stratospheric change. Core elements of the SPARC program include stratospheric data assimilation; process-oriented validation of chemistry-climate models (CCMVal); gravity waves; and laboratory studies.

A6 - THORPEX: Bridging weather and climate prediction

Convenor:

- **Gilbert Brunet, Environment Canada**

Invited:

- **Peter Houtekamer, Environment Canada**
- **Pierre Gauthier, Environment Canada**
- **Jeff Lazo, National Centre for Atmospheric Research**
- **Stephane Belair, MSC**

Description:

THORPEX is an international research and development programme responding to the weather related challenges of the 21st century to accelerate improvements in the accuracy of 1-day to 2- week high impact weather forecasts for the benefit of society and the economy. The main research topics of THORPEX cover predictability and dynamical processes, observing system, data assimilation and observing strategies and societal and economic applications. This session will focus on the interconnection between the weather high-frequency variability and the medium range time scales and beyond. This could include the following examples, but not excluding other relevant topics: i) global Rossby wave trains triggering sub-synoptic weather; ii) interaction between Madden-Julian Oscillation (MJO) and localised organised moist convection; iii) numerical weather-surface-ocean modelling uncertainties in representing the 2-3 weeks sub-seasonal time scales; iv) predictability studies of week-2 forecast systems using ensemble or singular vectors.

A7 - Atmospheric Networks and Observatories

Convenor:

- **Kimberly Strong, University of Toronto**

Invited:

- **Jean-Christopher Lambert, Belgian Institute for Space Aeronomy**
- **Jim Drummond, University of Toronto**

Description:

Accurate and timely measurements of chemical composition, radiation, clouds and aerosols, precipitation, winds, and meteorological parameters are essential to understanding our atmosphere. They allow early detection and long-term monitoring of changes in the physical and chemical state of the atmosphere, and are used to determine the processes that drive air quality, ozone depletion, and climate change. For example, recognizing the need for high quality measurements that use a variety of observation methods over a long period of time, the Canadian Network for the Detection of Atmospheric Change (CANDAC) has recently been formed. The first undertaking of CANDAC is the establishment of the new Polar Environment Atmospheric Research Laboratory at Eureka, Nunavut. Other facilities also exist across the country, participating in such efforts as Environment Canada's various national monitoring networks, the Aerosol Robotic Network, the Global Atmosphere Watch, the Network for Detection of Stratospheric Change, and the Baseline Surface Radiation Network. This session invites contributions describing: (i) existing, newly developed, and planned instruments, observatories, and networks for atmospheric measurements, and (ii) scientific results that have been derived from these measurements.

A8 - Atmospheric Composition and Chemistry

Convenors:

- **Jonathan Abbatt, University of Toronto**
- **Tom McElroy, University of Toronto**

Invited:

- **Randall Martin, Dalhousie University**
- **Jeff Brook, Environment Canada**

Description:

This session will focus on the chemical processes that control the changing composition of the atmosphere. Both oral and poster presentations are invited in the areas of laboratory studies, field measurements and chemical modeling studies. Contributions may be on any topic in tropospheric or stratospheric chemistry, as well as studies of biogeochemical processes that affect the levels of trace gases in the atmosphere.

A9 - General contributions in atmospheric sciences (Posters)

Convenors:

- **Paul Kushner, University of Toronto**

Description:

This poster session will consist of contributions related to meteorology and the atmospheric sciences that will not fit appropriately into the other poster and oral sessions.

C1 - Atmospheric and oceanic seasonal predictions

Convenor:

- **Jacques Derome, McGill University**

Invited:

- **George Boer, Environment Canada**

Description:

This session will be devoted to studies dealing with both the potential predictability and actual predictions of the atmosphere and oceans on the seasonal to interannual time scale. Statistical, dynamical and mixed statistical/dynamical approaches are of interest, as are studies on the economic

value of seasonal forecasts. Presentations that identify the source of the predictive skill in the forecasting system are particularly welcome.

C2/C3 - Climate Change Detection and Projection

Convenor:

- **Andrew Weaver, University of Victoria**
- **John Fyfe, Environment Canada**

Invited:

- **Ron Miller, NASA/GISS**

Description:

This session welcomes all papers concerning: 1) The detection of climate change above the background of natural, unforced variability as well as its attribution to changes in either anthropogenic of natural external forcing. 2) The projected 21st Century changes to the physical climate system (e.g. those involving the atmosphere, land surface, oceans and sea ice). Especially welcome will be analyses of the coupled ocean-atmosphere general circulation model simulations made in support of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).

O1 - Atmosphere and Ocean Dynamics

Convenor:

- **David Straub, McGill University**

Invited:

- **Glenn Flierl, Massachusetts Institute of Technology**
- **Shafer Smith, Courant Institute, New York University**
- **Michael Waite, National Center for Atmospheric Research**

Description:

Papers are solicited on aspects of fluid mechanics relating to atmospheric and/or oceanic dynamics. Topics could include geophysical turbulence, small scale mixing, waves, balance and general circulation theory/modelling. Contributions

dealing with theoretical aspects of climate modelling (e.g., statistical models of climate) as they relate to atmospheric and oceanic dynamics would also be welcome.

O2/O3 - Ocean Evolution and Change

Convenor:

- **Paul Myers, University of Alberta**
- **Howard Freeland, Dept. of Fisheries and Oceans**

Invited:

Description:

This session examines the state of the oceans over the last century, as well as our ability to simulate these oceanic states, either in a hindcast or forecast mode. In terms of examining the ocean's state, although an emphasis will be on how/whether the oceans have changed or are changing, papers looking at present day conditions are also welcomes. Papers examining all of the world's oceans will be considered. Additionally, this session will examine progress being made in the development of routine assessments of the state of the deep and coastal oceans and progress towards forecasting evolving ocean states. Thus, papers in this area should focus on the use and interpretation of near real-time data systems such as Argo, altimetry, upper-ocean T, sea level gauges and shelf/slope monitoring programs.

O4 - Interactions between the living ocean, the atmosphere and climate: what we know, suspect, and fear.

Convenor:

- **Maurice Levasseur, University of Laval**

Invited:

- **Peter Liss, University of East Anglia**
- **Ken Denman, Fisheries & Oceans Canada, Canadian Centre for Climate Modelling & Analysis, U. Victoria**

Description:

Exchanges of climatically active gases (CO2, DMS, NH4, N2O, etc.) and particles between the ocean and the atmosphere are an important yet still poorly understood part of the global climate system. This session seeks contributions on what we have learned recently, mainly but not exclusively under the auspices of the Surface Ocean-Atmosphere Study (SOLAS) IGBP program, and on where we should go next. Topics of interest include: biogeochemical cycling of climatically important gases in the World Ocean, responses of oceanic systems to dust deposition, impacts of ocean acidification, sea-air gas exchanges parameterisation, control and influence of oceanic gas and particle emissions on lower atmosphere chemistry and aerosol dynamics, and cloud dynamics over marine environments. Since this session also marks the end of the Canadian SOLAS Network, papers comparing the North Pacific and the North Atlantic ocean-atmosphere systems are especially welcome. This session will foster talks on how known and suspected ocean-atmosphere interactions may alter our views on how the Earth's climate will change in the next hundred years.

O5 - Coastal Oceanography and Inland Waters session

Convenors:

- **Jinyu Sheng, Dalhousie University**
- **Ram Yerubandi, National Water Research Institute**

Invited:

- **Michael Foreman, Institute of Ocean Sciences, DFO**
- **Kevin Lamb, University of Waterloo**
- **A.D. Rao, Indian Institute of Technology**

Description:

This session will focus on aspects of physical processes and modeling of coastal oceans, estuaries and inland waters. Topics could include for example: coastal physical oceanography, storm surges, tsunamis, estuarine dynamics, hydrology and hydrodynamics of large lakes, air-lake interactions, mixing and dispersion of material in the coastal waters.

Community Sessions

- **NSERC -- NSERC Information Session**
- **Joint NSERC-CFCAS Session**
- **YSCI -- Young Scientists Forum**

- **PRIV -- Private sector meteorology**
- **ECO -- Environmental Careers Organization meeting**
- **WIST -- The Women In Science and Technology**
- **CSA -- Canadian Space Agency**
- **CM -- Climate Monitoring - Information Session**

NSERC -- NSERC Information Session

Research Grants and Research Partnerships Programs

Convenor: Paul Potvin, NSERC - CRSNG

Description:

NSERC representatives will provide information relating to the Research Grants and the Research Partnerships Programs. An update will be provided regarding Corporate and Program news at NSERC, statistics from the 2006 Competition, the new target areas for the Strategic Grants program, and the new name and lifting of the moratorium on the Strategic Network Grants Program (previously called the Research Network Grants Program). This will be an interactive session so please come prepared with your questions.

Joint NSERC-CFCAS Session

Ocean, Atmosphere, and Climate Science Networks: Outcomes and Perspectives

Convenor: Gordon McBean, CFCAS; Janet Walden, NSERC

Description:

Over the past 5 years, CFCAS and NSERC-funded research networks have reinvigorated Canadian research in atmospheric, oceanic, and climate science. This session, which comes at a time when some of the leading networks are now completing their work, will showcase the achievements of some networks and offer perspectives on the future of network-based activities.

YSCI -- Young Scientists Forum

Convenor: Chris Fletcher, University of Toronto
Invited:

- **Stella Melo, Canadian Space Agency**
- **Mike LePage, RWDI AIR**
- **Adam Monahan, University of Victoria**
- **John Scinocca, Environment Canada**

Description:

For the first time on Monday May 29th, 2006, the CMOS 2006 Congress will host a special lunchtime session specifically for PhD students and new postdocs working in the fields of atmospheric science, climatology and oceanography.

The goals of the session are twofold:

- **To provide young scientists with the opportunity to consider the variety of career paths that their research training may offer to them. The main focus of the session will be two 20-minute presentations from established members of the research community outlining their own career development path and experiences. This will be followed by an open Q&A session with a panel of leading scientists from the academic, government and private sectors.**
- **To begin the establishment of a strong young scientists' community within CMOS. This community should have its own identity and help to build networks and collaborations between young researchers at institutions within Canada and beyond. A complimentary lunch is available for registered students (attendance must be confirmed at time of registration). Lunch will be available to non-students at the discounted rate of $12.**

This session promises to be worthwhile and rewarding for all young scientists in the CMOS community. It could help to shape difficult career choices and also to give young scientists a voice within CMOS.

PRIV -- Private sector meteorology

"Show me the Money II"

Convenor: Paul Temple, Pelmorex Media Inc.

Description:

This session, hosted by the private sector committee of CMOS, will feature speakers from the insurance industry, energy and other private sectors clients who will talk about how they believe the private sector of CMOS can meet their needs. What are these industries looking for? Are they well informed and served by the private sector CMOS members? Is there a buck to be made here? Come and find out! A presentation and question and answer session by the Private Sector Committee will also follow. A great chance to network.

ECO -- Environmental Careers Organization meeting

Meteorological Employment in Canada: Opportunities and Challenges

Convenor: Grant Trump, President & CEO

Description:

The last human resource study for Meteorological Employment in Canada, which was conducted by ECO Canada with support from CMOS, indicated there are approximately 9,200 meteorological practitioners across Canada employed in nearly 1,100 private and public sector organizations. In terms of human resources issues, the report also estimated that the projected future demand for trained practitioners in the private sector is high, with an estimated 3,195 vacancies forecasted by 2010. A large portion of these positions will require a post-graduate degree.

When asked about human resources issues affecting the industry, private sector employers pointed to shortages in the supply of trained meteorologists, which they indicated were exacerbated by low enrolments in related academic programs. Having documented competencies will close the gap between curriculum and industry requirements in practitioners. In addition, it would facilitate the creation of career awareness programs and much needed promotion of the occupation to attract students and encourage them to enroll in programs that will lead them to meteorological occupations.

At this session, ECO Canada will present more details on the findings of this study and discuss the importance of national occupational standards for meteorologists. This session is relevant to students or new graduates looking for information on employers; for educators in the process of renewing courses or creating courses in related fields; for employers to identify what other employers' human resources issues are and what skills are in high demand; and for practitioners to learn about the current state of meteorological employment in Canada.

WIST -- The Women In Science and Technology

Convenor: Ann McMillan, MSC

Description:

Every year, the committee of WIST (The Women In Science and Technology) of the Meteorological Service of Canada organize a luncheon at CMOS. This year there will be a panel discussion on professional careers in meteorology and oceanography. You will hear experiences and stories from three women whose professional experiences are distinctly different, but all are strongly based on their love and dedication to science.

You are invited to meet and listen to the following three outstanding women and draw inspiration from their careers and stories:

Anne Douglass, Scientist, National Aeronautics and Space Administration
Nancy Cutler, retired Director General, Meteorological Service of Canada
Susan Woodbury, President, Canadian Meteorological and Oceanographic Society

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CSA -- Canadian Space Agency

Convenor: Stella Melo

Description:

The Canadian Space Agency is committed to leading the development and application of space knowledge for the benefit of Canadians and humanity. Our mandate is "to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians". The Agency has a status equivalent to that of a department of the federal government. Reporting to the Minister of Industry, the Chief Executive Officer of the Agency is the President. Under the President, five core functions are carried out (Canadian Astronaut Office, Space Technologies, Space Science, Space Programs, and Space Operations), as well as four executive functions (Communications and Public Affairs, Policy, Planning and Relations, Corporate Management, and Audit Evaluation and Review) and four corporate functions (Information Management and information Technology, Human Resources, Security and Facilities, and

Legal Services). To meet its objectives, the Agency partners with government, industry, universities, and international organizations.

CSA - Space Science listen to the community through Science Advisory Committees. The Space and Atmospheric Environment Advisory Committee (SAEAC) is composed of 16 members of the Canadian science community and meets at least once a year to provide advice to the CSA on scientific/programmatic matters. In addition, once each other year, CSA, together with SAEAC, host a community-wide workshop to review strategies and program priorities.

CSA - Space Science respond to the needs of the atmospheric sciences community in Canada by releasing Announcements of Opportunities (AO) and Requests for Proposals (RFP) for the development of instrument and mission concepts (the design and built of specific space instruments and missions is led by CSA -Space Programs with the support of CSA -Space Science). Special opportunities in international missions are also considered by the Agency. Within the objective of supporting our space missions, CSA - Space Science also support atmospheric modelling development as well as satellite validation campaigns involving balloons, aircrafts, and ground-based instrumentations. We also support the community through the CSA Grants and Contributions Programs sub-divided in 1) Canadian Space Agency Support for Space Science Conferences, 2) Space Science Enhancement Program, 3) CSA Support to NSERC Industrial Research Chair, 4) Fellowships in space science program, 5) CSA Supplements to NSERC Scholarships and Fellowships.

This session will discuss the programs and opportunities offered by CSA - Space Science to the Canadian atmospheric science community. We will provide an overview of our main programs and discuss how we support the community. Bring your questions! We especially invite students and Post-docs interested to learn more about working in space science in Canada - how to go from dream to reality!

CM -- Climate Monitoring - Information Session

Convenor: Thomas R. (Tom) Nichols, Environment Canada - Meteorological Service of Canada (MSC)

Description:

In an effort to ensure data availability, Environment Canada's atmospheric/hydrometric monitoring and data archiving are undergoing a significant transition. Tom Nichols, Director General of Weather and Environmental Monitoring, will present an overview of the integrated monitoring

and data management framework. This presentation will summarize the status of the observing networks and highlight some interesting new technologies.

Plenary Speakers

David Karoly

Williams Chair Professor of Meteorology
School of Meteorology
University of Oklahoma
100 E. Boyd Street, Room 1366
Norman OK 73019-1013
Telephone: (405) 325 6446
Facsimile: (405) 325 7689
E-mail: dkaroly@ou.edu

David Karoly is Chair Professor of Meteorology at University of Oklahoma. He is active in research into the dynamics of the large-scale circulation of the atmosphere and its variability on time scales from days to decades. Specific research interests include greenhouse climate change, stratospheric ozone depletion and interannual climate variations due to the El Nino-Southern Oscillation. He is a member of a number of international and national committees, including the WMO Expert Team on Climate Change Detection, Data and Indices, the US National Research Council Climate Research Committee, and the Council of the American Meteorological Society. In 1999, he was elected a Fellow of the American Meteorological Society for outstanding contributions to the atmospheric sciences over a substantial period of years.

Dr. Anne R. Douglass

Deputy Aura (EOS Chemistry) Project Scientist
Code 613.3
Goddard Space Flight Center
National Aeronautics and Space Administration
Greenbelt, MD 20771
USA
Phone: (301) 614-6028
Fax: (301) 614-5903
Email: anne.r.douglass@nasa.gov

Anne Douglass is Deputy Project Scientist for EOS Aura at NASA Goddard Space Flight Center. Her research interests include assimilating meteorological fields into three-dimensional chemistry and transport models for interpretation of constituent observations from satellite, balloon, aircraft and ground based platforms. She is a fellow of the American Meteorological Society and a winner of a Clare Boothe Luce Award for Women in Mathematics and Science.

Fiamma Straneo

Associate Scientist
Physical Oceanography
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
Mailstop: 21
Phone: +1 508 289 2914
fstraneo@whoi.edu

Fiamma Straneo is an Assistant Scientist at Woods Hole Oceanographic Institution. She gained her PhD in Physical Oceanography from University of Washington. Fiamma's research uses both analytical and non-hydrostatic numerical models to investigate the dynamics of oceanic convective processes, interannual to decadal variability at deep convective sites and boundary current and interior exchanges in the subpolar North Atlantic.

Mel Shapiro

NOAA Office of Weather and Air Quality
c/o NCAR/MMM
P.O. Box 3000
Boulder, CO 80307-3000
Phone: 303-497-8965
Fax: 303-497-8171
Email: mshapiro@ucar.edu

Mel Shapiro is a Senior Research Meteorologist at NOAA in Maryland. He gained his PhD in Meteorology from Florida State University. Mel has worked for over 30 years at leading US institutions in the fields of meteorology and air quality. In 1988 he was elected an AMS fellow and is current co-chair of the THORPEX science advisory board.

Edward Mahoney

Warning Decision Training Branch
3200 Marshall Ave
Norman, OK 73072-8028
Ph: (405) 366-6560
Fax: (405) 366-6557

Ed Mahoney has been Chief of the Warning Decision Training Branch, Oklahoma since 2001. His expertise is in operational weather forecasting and in 1995 he was named National Weather Association Operational Forecaster of the Year. He has been honoured by several bodies for his innovations in operational winter weather forecast techniques. Ed was recently elected to serve as the president of the Central Oklahoma Chapter of the American Meteorological Society (COCAMS).

Daniel Jacob

Pierce Hall, 29 Oxford St., Harvard U., Cambridge, MA 02138 U.S.A.
Phone: 1-617-495-1794
Fax: 1-617-495-4551
email: djj@io.harvard.edu
URL: http://www-as.harvard.edu/people/faculty/djj

Daniel Jacob has been Professor of Atmospheric Chemistry and Environmental Engineering at Harvard University since 1994. He gained his PhD in Environmental Engineering from Caltech. His current research is focused on atmospheric chemistry. In 2003, Daniel was awarded the NASA Distinguished Public Service Medal for his contributions to the understanding of fundamental physical and chemical processes in the lower atmosphere

Mark Baldwin

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14508 NE 20th St.
Bellevue, WA 98007-3713 USA
(425) 644-9660 x 323
(425) 644-8422 [FAX]
mark@nwra.com

Mark Baldwin is a senior Research Scientist in the Atmospheric Sciences Group at Northwest Research Associates and adjunct Faculty at the Department of Atmospheric Science, Colorado State University. He has a PhD in atmospheric sciences from the University of Washington. Mark is the climate editor of BAMS and sits the AMS Committee on Atmospheric and Oceanic Fluid Dynamics. He is also a qualified high-performance driving instructor.

Public Lecture

The Science (and Politics) of Global Warming

Date: **Tuesday, May 30, 2006**
Time: **7:00 PM**
Location: **Council Chamber, Toronto City Hall, 100 Queen Street West, Toronto**
Admission: **FREE**

Prof. Weaver is a leading expert on climate dynamics and ocean circulation. He holds the Canada Research Chair in Climate Modelling and Analysis at the University of Victoria, and is the Chief Editor of the Journal of Climate published by the American Meteorological Society.

Abstract

Prof. Andrew Weaver
School of Earth and Ocean Sciences
University of Victoria
Gordon Head Complex
PO Box 3055 STN CSC
Victoria, BC, V8W 3P6, Canada
Tel: (250) 472-4006; Fax: (250) 472-4004;

Andrew Weaver is Professor in the School of Earth and Ocean Sciences at University of Victoria, BC. His research focuses on the large-scale ocean circulation and the role of the oceans in climate, with a special emphasis upon three-dimensional numerical modelling. He has recently become interested in examining paleoclimate using coupled atmosphere ocean models.

In February 2007 the United Nations Intergovernmental Panel on Climate Change (IPCC) will release its Fourth Assessment Report on climate change science. Six years will have elapsed since the IPCC released its Third Assessment Report containing the statement:

"There is now new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

The science leading up to this statement will be addressed along with subsequent advances in climate change science. A historical perspective on the Earth's climate over the last 400,000 years, and the science of global warming over the last 200 years will also be offered. Finally, a discussion of some outstanding uncertainties and a look towards the future will be presented.

Women in Science and Technology (WIST)

Traditionally, during the CMOS Congress, there is a luncheon to focus on women's issues in a professional environment. Men and women from all scientific professions are welcome to this year's Women In Science and Technology (WIST) meeting on Thursday, June 1, 2006 from 12:30 pm to 2:00 pm.

A panel discussion on professional careers in meteorology and oceanography will be the focus. The panelists are:

- Anne Douglass, an esteemed scientist from National Aeronautics and Space Administration (NASA)
- Susan Woodbury, President of CMOS and President of Woodbury Management Solutions
- Nancy Cutler, retired Director General of the Meteorological Service of Canada (MSC)

We will learn from the contrasting experiences and stories of three women who represent careers in the private sector, the Canadian government and the NASA administration. Their professional experiences are distinctly different, but all strongly based on their love and devotion to science.

Please come to meet these three incredible women and draw inspiration from their unusual careers and stories. Our moderator, Ann McMillan of the MSC will be there to facilitate the session and to take your questions. Ann is the new World Meteorological Organization' (WMO) gender focal point for the MSC.

CMOS 2006
Young Scientists' Forum

A career-development session for PhD students and postdocs working in any area of atmospheric or oceanographic science

The session addresses the question:
"What can I do with a PhD in atmospheric or oceanographic science?"

1. Careers presentations given by:
   - **Stella Melo, Canadian Space Agency**
   - **Adam Monahan, U. of Victoria**
2. Open panel discussion also featuring:
   - **Mike LePage, RWDI Toronto**
   - **John Scinocca, Environment Canada**

TIME: Monday, May 29th @ 12:30pm
LOCATION: Grand Ballroom (East), Sheraton Centre, Toronto.
Complimentary lunch provided for registered students. Discounted* lunch available for postdocs.

* Lunch rate is C$12, payable at registration.

Week at a Glance

Toronto CMOS 2006 Conference Schedule Week at a Glance

Calendrier Du Congrès - Aperçu de la semaine

Day	Sunday May 28 / dimanche 28 mai	Monday May 29 / lundi 29 mai		Tuesday May 30 / mardi 30 mai		Wednesday May 31 / mercredi 31 mai		Teacher/ Media Day	Thursday June 1 / jeudi 1 juin	
Time										
8:30 AM		Plenary Talks		Plenary Talks		Plenary Talks		Presentations	Plenary Talks	
10:00 AM	CMOS Pre-Conference Meetings/	Coffee Break		Coffee Break		Coffee Break		Coffee Break	Coffee Break	
10:30 AM		Science Sessions	CSA	Science Sessions	Private Sector Meteorology	Science Sessions		Presentations	Science Sessions	
11:00 AM										
12:30 PM	Lunch	Lunch	Young Scientists Forum	Lunch	Parsons/ Patterson Luncheon	Lunch	Climate Monitoring	Lunch/Media Interviews	Lunch	Women in Science and Technology & Panel Discussion
1:00 PM										
2:00 PM										
3:00 PM	CMOS Pre-Conference Meetings Continued	Science Sessions	ECO	Science Sessions	NSERC	Science Sessions	NSERC-CFCAS	Presentations	Science Sessions	
4:00 PM		Poster Session with Refreshments		Poster Session with Refreshments		Poster Session with Refreshments		End of Teacher/Media Day	Poster Session with Refreshments	
5:00 PM										
6:00 PM				UNSTABLE						
Evening	Ice Breaker	CMOS Annual General Meeting	Young Scientist Gathering	Public Lecture held at Toronto City Hall		Banquet				

Day 0 / jour 0 - Sunday May 28 / dimanche 28 mai

Room/salle	Time/heures	Session Name/Nom de la séance
	09:00-18:00	**BUSINESS MEETINGS / RÉUNIONS D'AFFAIRES**
Elgin	**09:00-16:00**	**CNC SCOR**
Kenora	**09:00-12:00**	**Private Sector/Secteur Privé**
Wentworth	**09:00-12:00**	**Publications**
Huron	**09:00-10:00**	**School & Public Education / Écoles et éducation publique**
Huron	**10:00-11:00**	**University & Prof. Education / Université & éducation prof.**
Huron	**11:00-12:00**	**Students / Étudiants**
	12:00-13:00	LUNCH / DÉJEUNER

Wentworth	**13:00-14:00**	**Centre Chairs/ Présidents de Centres**
Kenora	**13:00-14:00**	**Scientific / Scientifique**
Wentworth	**14:00-16:00**	**CMOS COUNCIL / CONSEIL SCMO**
Wentworth	**16:00-18:00**	**CFCAS AGM**
Waterfalls Garden	**18:30-**	ICEBREAKER / BRISE GLACE

Day 1 / jour 1 - Monday May 29 / lundi 29 mai

Room/salle	Time/heures	Session Name/Nom de la séance
Grand East	**08:30-10:00**	**P1- Plenary Day 1/Plénière jour 1**
	10:00-10:30	COFFEE BREAK / PAUSE CAFÉ
Grand West	**10:30-12:30**	**A1- Warnings & Tech. in Forec. / Avertissement & tech. in prév.(1)**
Grand Centre	**10:30-12:30**	**A2- Remote Sensing of Atm. & Surface / Télédétection (1)**
Civic North	**10:30-12:30**	**A3- Arctic Weather & Clim. IPY / Météo et Océan. IPY Arctique (1)**
Civic South	**10:30-12:30**	**O1- Atm. & Ocean Dynamics (1)**
Grand Centre - P	**10:30-11:30**	**CSA Information session / Information de l'ASC**
	12:30-14:00	LUNCH / DÉJEUNER
Grand Centre - P	**12:30-14:00**	**Young Scientists Forum / Jeunes scientifiques**
Grand West	**14:00-16:00**	**A1- Warnings & Tech. in Forec. / Avertissement & tech. in prév. (2)**
Grand Centre	**14:00-16:00**	**A2- Remote Sensing of Atm. & Surface / Télédétection (2)**
Civic North	**14:00-16:00**	**A3- Arctic Weather & Clim. IPY / Météo et Océan. IPY Arctique (2)**
Civic South	**14:00-16:00**	**O1- Atm. & Ocean Dynamics (2)**
Grand Centre - P	**14:30-15:30**	******* ECO- Environmental Careers Org. / Organisation des carrières env.**
	16:00-16:30	COFFEE BREAK / PAUSE CAFÉ
Poster Area 1	**16:00-18:00**	**A1 Posters (a,b,c)**
Poster Area 2	**16:00-18:00**	**A2 Posters (a,b,c)**
Poster Area 3	**16:00-18:00**	**A3 Posters**
Poster Area 4	**16:00-18:00**	**O1 Posters (a,b)**
	17:00	DRINKS/SNACKS

Day 2 / jour 2 - Tuesday May 30 / mardi 30 mai

Room/salle	Time/heures	Session Name/Nom de la séance
Grand East	**08:30-10:00**	**P2- Plenary Day 2/ Plénière jour 2**
	10:00-10:30	COFFEE BREAK / PAUSE CAFÉ
Dufferin Room	**10:30-12:30**	**PS- Private Sector Meteorology / Météo secteur privé**
Grand West	**10:30-12:30**	**A2- Remote Sensing of Atm. & Surface / Télédétection (3)**
Grand Centre	**10:30-12:30**	**A5- SPARC / SPARC (1)**
Civic North	**10:30-12:30**	**C1- Atm. & Ocn. Seasonal Pred./ Prév. saisonaires atm. & océan. (1)**
Civic South	**10:30-12:30**	**A4- Carbon Cycle Measurement & Interaction / Cycle du carbone (1)**
Grand East	**12:30-14:00**	LUNCH / DÉJEUNER- Parsons/Patterson
Grand West	**14:00-16:00**	**A1- Warnings & Tech. in Forec. / Avertissement & tech. in prév. (3)**
Grand Centre	**14:00-16:00**	**A5- SPARC / SPARC (2)**
Civic North	**14:00-16:00**	**C1- Atm. & Ocn. Seasonal Pred./ Prév. saisonnières atm. & océan. (2)**
Civic South	**14:00-16:00**	**A4- Carbon Cycle Measurement & Interaction / Cycle du carbone (2)**
	16:00-16:30	COFFEE BREAK / PAUSE CAFÉ
Dufferin Room	**14:30-15:30**	**NSERC Information / Information du CRSNG**
Poster Area 5	**16:00-18:00**	**A4 Posters (a,b)**
Poster Area 6	**16:00-18:00**	**A5 Posters (a,b,c)**
	17:00	DRINKS/SNACKS
Toronto City Hall	**19:00 21:00**	PUBLIC LECTURE Andrew Weaver CONFÉRENCE PUBLIQUE

Day 3 / jour 3 - Wednesday May 31 / mercredi 31 mai

Room/salle	Time/heures	Session Name/Nom de la séance
Grand East	**08:30-10:00**	**P3- Plenary Day 3/ Plénière jour 3**
Grand Centre - P	**09:00-13:45**	**Introduction of Media day / Présentation de la journée des média**
Dufferin Room	**09:00-16:00**	**Teachers Day / Journée des enseignants**
	10:00-10:30	COFFEE BREAK / PAUSE CAFÉ
Grand West	**10:30-12:30**	**A5- SPARC / SPARC (3)**
Grand Centre	**10:30-12:30**	**A7- Atm. Networks and Observatories / Réseaux atm. &**

		obs. (1)
Civic North	**10:30-12:30**	**A6- THORPEX / THORPEX (1)**
Civic South	**10:30-12:30**	**O2 / O3- Ocean Climate / Climat de l'océan (1)**
Grand Centre - P	12:00-13:45	LUNCH & Media Interviews/ DÉJEUNER et interviews des média
	12:30-14:00	LUNCH / DÉJEUNER
Dufferin Room	**12:30-14:00**	**Climate Monitoring in EC / Surveillance du climat à EC**
Grand West	**14:00-16:00**	**C2/C3- Climate Change / Changement climatique (1)**
Grand Centre	**14:00-16:00**	**A7- Atm. Networks and Observatories / Réseaux atm. & obs. (2)**
Civic North	**14:00-16:00**	**A6- THORPEX / THORPEX (2)**
Civic South	**14:00-16:00**	**O2 / O3- Ocean Climate / Climat de l'océan (2)**
Grand Centre - P	**14:00-16:00**	**Joint NSERC-CFCAS Session - Network-based Research /Recherche par réseaux**
	16:00-16:30	COFFEE BREAK / PAUSE CAFÉ
Poster Area 1	**16:00-18:00**	**A6 Posters (a,b)**
Poster Area 2	**16:00-18:00**	**A7 Posters (a,b)**
Poster Area 3	**16:00-18:00**	**A9- Atmospheric Science Posters / Affiches Science Atm.**
Poster Area 4	**16:00-18:00**	**C2/C3 Posters**
Poster Area 5	**16:00-18:00**	**O2/O3 Posters (a,b)**
Grand Centre	**19:00 -**	CMOS BANQUET SCMO

Day 4 / jour 4 - Thursday June 1 / jeudi 1 juin

Room/salle	Time/heures	Session Name/Nom de la séance
Grand East	**08:30-10:00**	**P4- Plenary Day 4/ Plénière jour 4**
	10:00-10:30	COFFEE BREAK / PAUSE CAFÉ
Grand West	**10:30-12:30**	**O5- Coastal Oceanography / Océanographie côtière (1)**
Grand Centre	**10:30-12:30**	**A8- Atm. Chemistry & Composition/ Chimie atmosphérique (1)**
Civic North	**10:30-12:30**	**C2/C3- Climate Change / Changement climatique (2)**
Civic South	**10:30-12:30**	**O4- Living Ocean, Atmosphere & Climate Interactions / Interactions océan vivant, atmos. & climat (1)**
	12:30-14:00	LUNCH / DÉJEUNER
Grand Centre - P	**12:30-14:00**	**Women in Science and Technology Panel Discussion / femmes scientifiques**
Grand West	**14:00-16:00**	**O5- Coastal Oceanography / Océanographie côtière (2)**
Grand Centre	**14:00-16:00**	**A8- Atm. Chemistry & Composition/ Chimie atmosphérique (2)**
Civic North	**14:00-16:00**	**C2/C3- Climate Change / Changement climatique (3)**
Civic South	**14:00-16:00**	**O4- Living Ocean, Atmosphere & Climate Interactions / Interactions océan vivant, atmos. & climat (2)**
	16:00-16:30	COFFEE BREAK / PAUSE CAFÉ

Poster Area 6	**16:00-18:00**	**A8 Posters (a,b,c)**
Poster Area 7	**16:00-18:00**	**O4 Posters (a,b)**
Poster Area 8	**16:00-18:00**	**O5 Posters**
	17:00	DRINKS/SNACKS
	18:00	**CMOS Congress 2006 Closes**

Legend

1. Black Creek Pioneer Village
2. Casa Loma
3. Colborne Lodge
4. Exhibition Place & NTC
5. Fort York
6. Gibson House Museum
7. Montgomery's Inn
8. Ontario Place
9. Ontario Science Centre
10. Scarborough Historical Museum
11. Spadina Historic House and Gardens
12. Todmorden Mills Museum
13. Toronto Centre for the Arts
14. Toronto Aerospace Museum
15. Toronto Zoo
16. Union Station
17. Woodbine Race Track & Slots

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British 416-593-1267
French 416-925-8041
German. 416-925-2813
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Pearson, Terminal 3 416-776-5100
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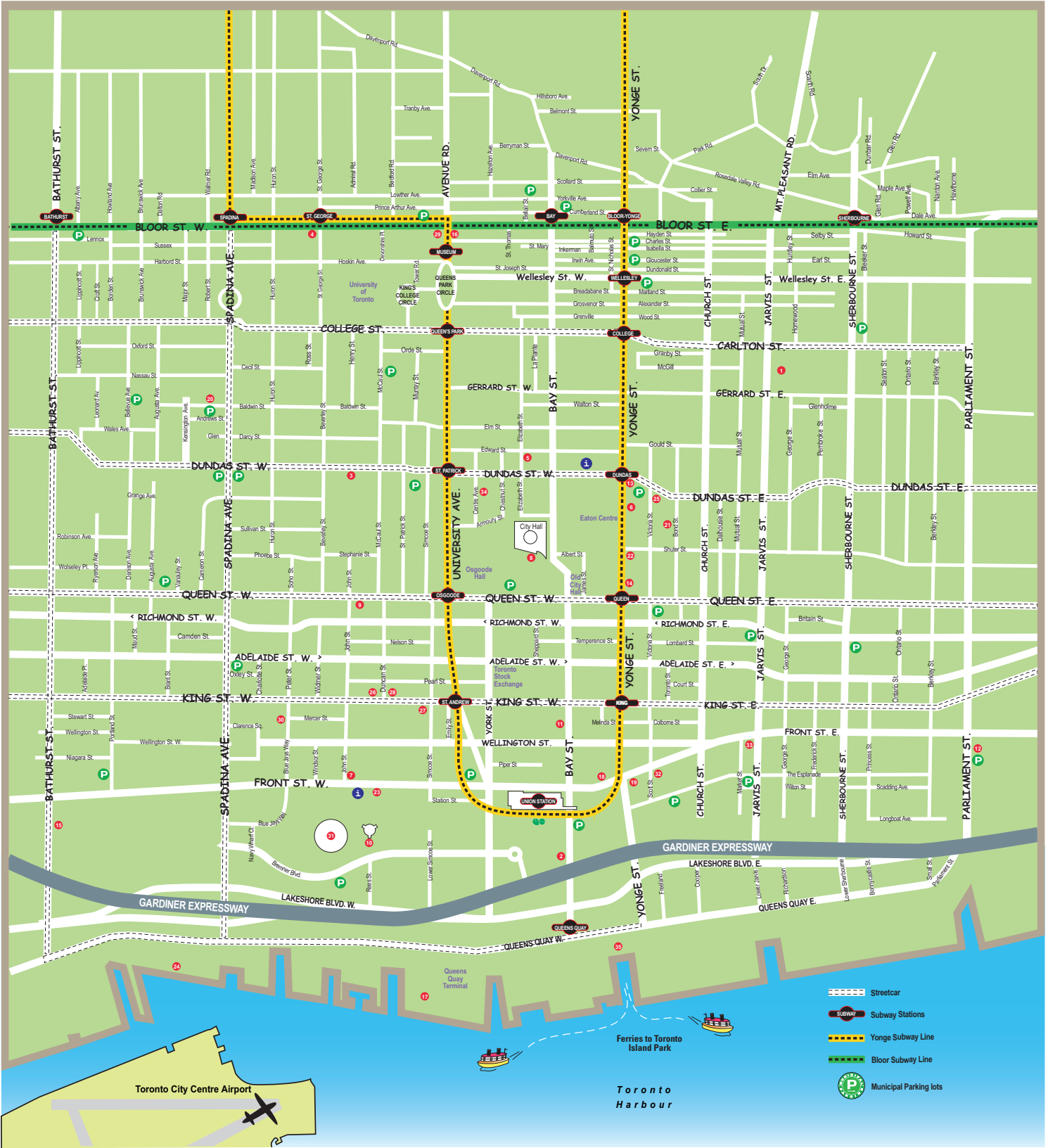
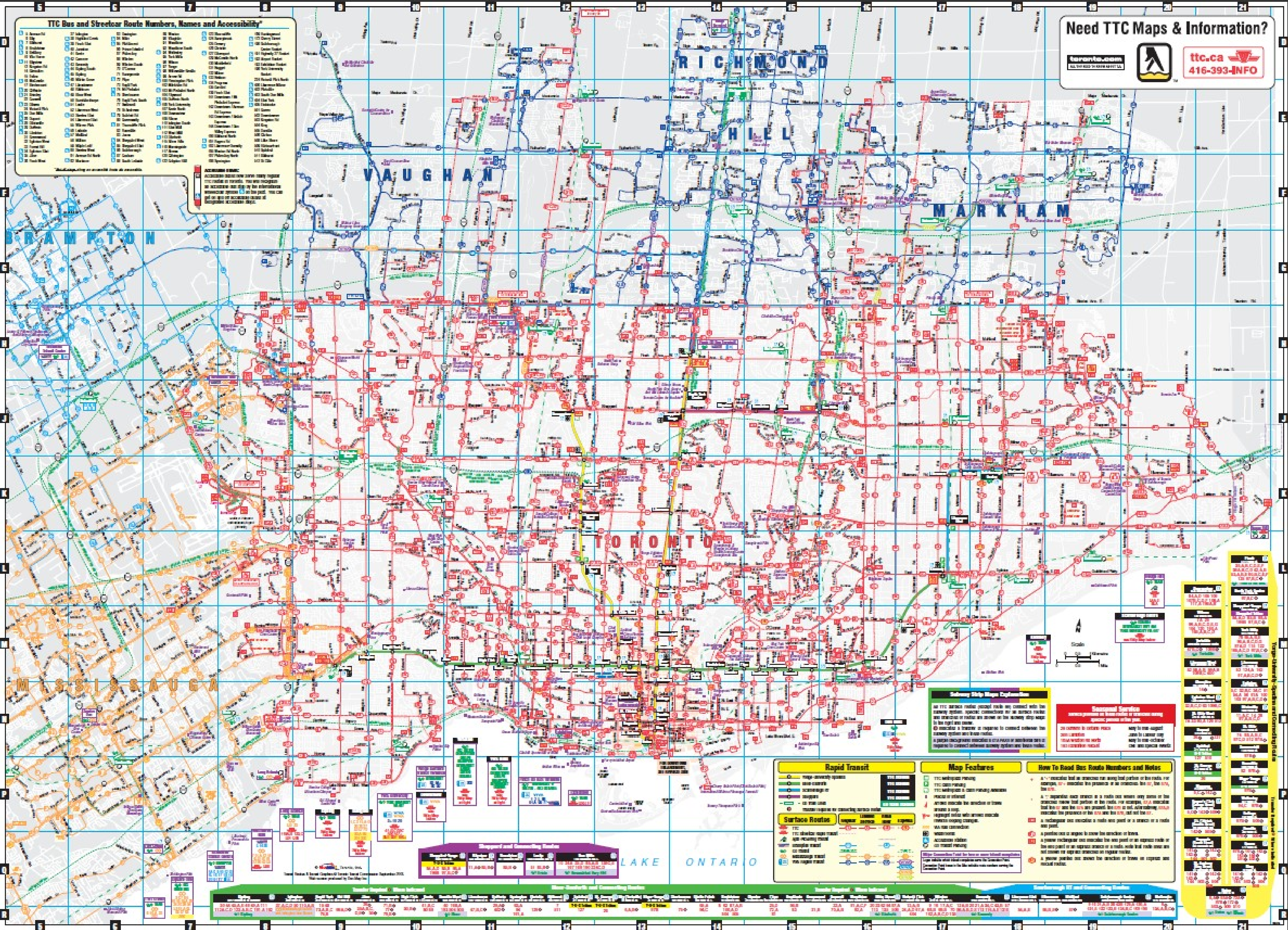
Toronto Island Ferry 416-392-8193
Greyhound bus service 416-367-8747
VIA Rail. 416-366-8411
Ferry to Rochester "The Breeze" 1-877-825-3774



Legend

1. Visitor Information
2. Allan Gardens Conservatory
3. Air Canada Centre
4. Art Gallery of Ontario
5. Bata Shoe Museum
6. Bus Terminal
7. Canon Theatre
8. CBC Broadcast Centre
9. City Hall, Nathan Phillips Square
10. CityTV
11. CN Tower
12. Design Exchange
13. Distillery District
14. Dundas Square
15. Elgin & Winter Garden Theatre
16. Fort York
17. Gardiner Museum of Ceramic Art
18. Harbourfront Centre
19. Hockey Hall of Fame
20. Hummingbird Theatre
21. Kensington Market
22. Mackenzie House
23. Massey Hall
24. Metro Toronto Convention Centre
25. Music Garden
26. Olympic Spirit Centre
27. Princess of Wales Theatre
28. Roy Thomson Hall
29. Royal AlexandraTheatre
30. Royal Ontario Museum
31. Second City
32. SkyDome
33. St. Lawrence Centre
34. St. Lawrence Market
35. Textile Museum
13. T.O. Tix
35. Toronto Island Ferry Terminal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Monday to Friday rush hours only from approx. 6:00-9:00am and 3:00-6:00pm

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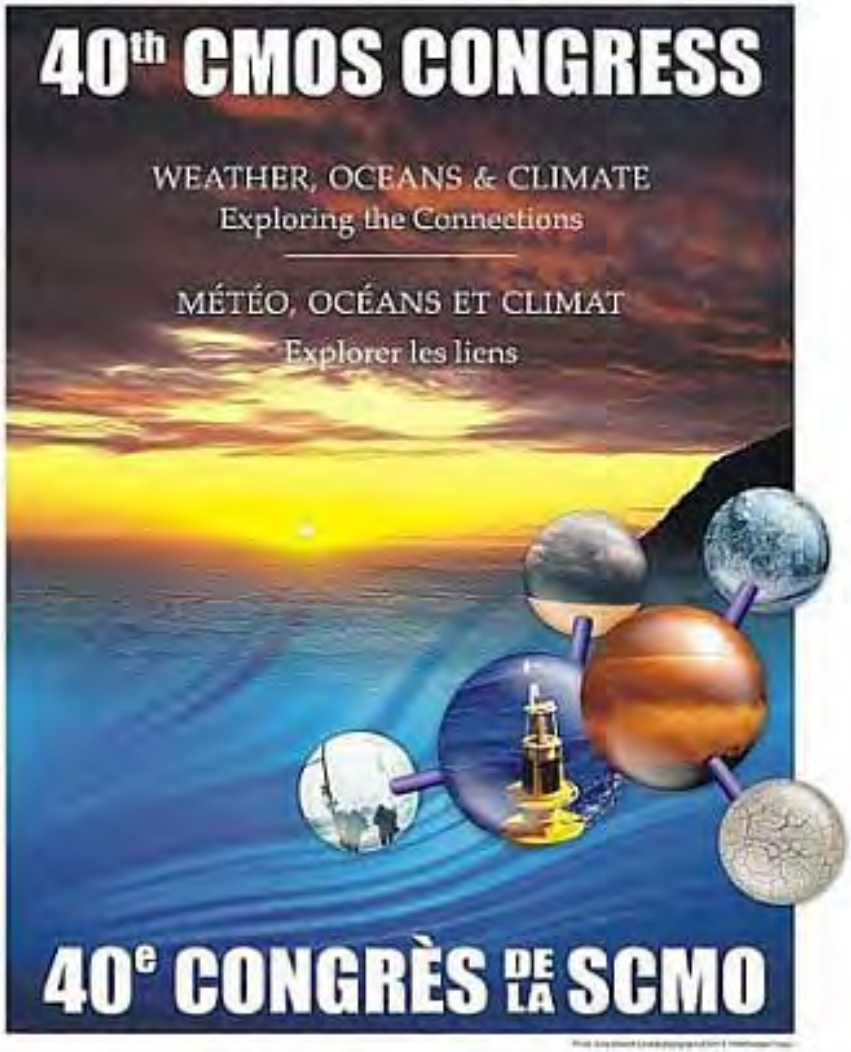

Toronto, Ontario
29 May/mai - 1 June/juin, 2006

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

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ABSTRACTS

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In the index located at the end of some documents, the name of each author is followed by the ID number of all the corresponding abstracts and their presentation sequence number.

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

1C4.6

Sensitivity study and thermodynamics analysis of the sea ice at the North Water Polynya NOW.

André April [1], *Yves Gratton* [3], *Dave Barber* [2]
[1] Université du Québec à Rimouski
[2] Universite du Manitoba
[3] Institut recherche scientifique du Quebec INRS-ETE eau-terre-environnement
Contact:aapril@mediom.com

The North Water Polynya (NOW) in the north of the Baffin Bay, is a polynya maintain by latent and sensible mechanisms. During the 1998 NOW experiment, observers remarks that coastal sea ice is thinner and break-up earlier on the east side of the polynya near Greenland than the west side near the Canadian Ellesmere Island. With the help of 1 dimensional thermodynamic model, including radiatives flux and oceanic heat flux correctly submitted to a sensitive study, I explain the nature of the sea ice different on both sides of the polynya. Meteorological aspects and oceanic heat flux contributes to understand the coastal sea ice condition observed. The study permits too, to develop new watching tool in the context of the warming in the arctic resulting from the climate change.

4B4.5

Changes in Winter Cyclone Frequencies and Strengths Simulated in Climate Change Experiments: Results from Models Participating in the IPCC Diagnostic Exercise

Steven Lambert, *John Fyfe*
CCCma, Meteorological Service of Canada
Contact:steve.lambert@ec.gc.ca

The effect of enhanced greenhouse warming on the behaviour of mid-latitude cyclones is examined for changes in the total number of cyclone events and for changes in the number of intense events using the daily averaged mean sea level pressure simulated by coupled climate models participating in the IPCC AR4 diagnostic exercise. Results are presented for a set of scenarios which were produced using a wide range of increasing levels of greenhouse gases. For the enhanced greenhouse warming experiments, the models simulated a reduction in the total number of events and an increase in the number of intense events. This is a robust result, which essentially all the models exhibit. Comparison of the results for each of the scenarios shows that the magnitude of the changes in the number of simulated events increases with increasing levels greenhouse gas forcing used in the scenarios.

4C2.9

Development of a Nested-Grid Hydrodynamic Model for Simulating Circulation and Thermal Structure in Lake Huron and Georgian Bay

Jinyu Sheng [1], *Ram Yerubandi* [2]
[1] Dalhousie University
[2] Environment Canada, National Water Research Institute
Contact:jinyu.sheng@dal.ca

The Lake Huron ecosystem, which consists of fresh-water fisheries, wildlife, shoreline marshes and wetlands, has been significantly affected by natural and anthropogenic activities. Knowledge of water movements and temperature distributions in the lake will be particularly useful to improve the current understanding of the chemical and biological processes that occur simultaneously in the lake. A nested-grid hydrodynamic model was developed to simulate circulation and temperature distributions in Lake Huron and Georgian Bay. This nested-grid model is based on the three-dimensional, primitive-equation z-level ocean circulation model known as CANDIE. The nested system consists of two sub-components: a coarse-resolution outer model covering Lake Huron and Georgian Bay with a horizontal resolution of roughly 2.5 km, and the fine-resolution inner model covering eastern Lake Huron and northwestern Georgian Bay with a horizontal resolution of roughly 900 m. Both the outer and inner models have 30 z-levels in the vertical. To

assess the model performance, we simulate the three-dimensional circulation and temperature distributions of Lake Huron and Georgian Bay in 1974-75 and compare the model results with observations made in the lake. We demonstrate that outer model of the nested system simulates reasonably well the large-scale circulation and seasonal evolution of thermal stratifications in Lake Huron and Georgian Bay, and the inner model produces reasonably well the three-dimensional flow and thermal structure over the coastal boundary layer close to the eastern shore of the lake.

4B2.4
Numerical study of Baroclinic Dynamics in Lunenburg Bay of Nova Scotia
Li Zhai , Jinyu Sheng
Dalhousie University
Contact:li.zhai@phys.ocean.dal.ca

Measurements made by the advanced ocean observing system in Lunenburg Bay of Nova Scotia demonstrate that the coastal circulation and hydrographic structures in the bay are affected significantly by tides, wind and surface heat/freshwater fluxes. We investigate the baroclinic response of Lunenburg Bay to wind and tidal forcing using two types of numerical models. We first use a linear reduced gravity model to improve our understanding of essential dynamics of the upwelling/downwelling and baroclinic circulation in the bay. For the first baroclinic mode in summer months, the baroclinic response of the bay to the steady offshore wind forcing is symmetric after 2 days. Upwelling occurs on the north shore, south shore and the mouth of the bay within the first Rossby radius of deformation. The baroclinic coastal jet builds up along the coast and forms an anticyclonic circulation inside the bay after 1 day. We next carry out a realistic simulation using the nested-grid coastal circulation modeling system developed recently for the bay based on CANDIE, which is a three-dimensional, primitive equation, ocean circulation model. The results produced by the nested-grid system demonstrate that the temperature and salinity distributions in the bay are affected strongly by surface heat and freshwater fluxes, upwelling/downwelling associated with wind and tides, and advection of offshore waters from the inner Scotian Shelf.

4DPA8.12
Assessing the Performance of a High-Resolution Coastal Circulation Model in Simulating the Storm-Induced Circulation in Lunenburg Bay of Nova Scotia
Jun Zhao , Jinyu Sheng , Li Zhai
Dalhousie University
Contact:jun.zhao@phys.ocean.dal.ca

A nested-grid coastal circulation model was developed for Lunenburg Bay of Nova Scotia based on the three-dimensional ocean circulation model known as CANDIE, as part of the CMEP (Center of Marine Environmental Prediction) project funded by the CFCAS. The nested-grid model is used to simulate the storm-induced circulation in Lunenburg Bay of Nova Scotia during Hurricane Juan in September 2003. The nested-grid model has two components, a coarse-resolution (130 m) outer model covering Mahone Bay, Lunenburg Bay and Rose Bay, and a fine-resolution (60 m) inner model covering Lunenburg Bay and adjacent two coves. The two-way nesting technique based on the semi-prognostic method is used to exchange information between the inner and outer models. The outer model results are used to specify the open boundary conditions of the inner model. The nested-grid model is forced by wind stress and wave radiation stress gradients applied at the sea surface, tides and coastal trapped waves specified at the outer model open boundaries. The radiation stress gradients of surface waves are produced by the nearshore wave model known as SWAN. The model results demonstrate strong interactions between the local wind stress, surface waves, tidal forcing, and remotely generated coastal trapped waves during the study period. We compare the model results with the observed surface elevations and currents in the bay. We demonstrate that the nested-grid model performs very well in simulating the time evolution of storm-induced surface elevation and

reasonably well in simulating the M2 tidal current ellipses and storm-induced currents in the bay during Hurricane Juan.

4DPA8.8

Application of a nested-grid hydrodynamic model to study circulation and hydrographic structures and associated variability in the Bras d'Or Lakes of Nova Scotia

Bo Yang , Jinyu Sheng
Dalhousie University
Contact:Bo.Yang@phys.ocean.dal.ca

A nested-grid circulation modeling system was constructed recently for the Bras d'Or Lakes of Nova Scotia, as part of a research project funded by the AquaNet for developing research tools to study biological and environmental limitations of Multinucleated Spherical X in the lakes. The nested-grid system is based on the three-dimensional, primitive-equation, z-level ocean circulation model known as CANDIE. The nested-grid system consists of a fine-resolution (120 m) inner model embedded inside a coarser-resolution (400 m) outer model. The outer model domain covers the whole Lakes and the inner model domain covers St. Patrick's Channel. The outer model results are used to specify the open boundary conditions of the inner model. Two numerical experiments are conducted to study the circulation, upwelling/downwelling, hydrographic distributions, and associated variability in the lakes. In the first experiment the nested-grid system is forced by tides specified at the mouth of the Great Bras d'Or Channel (GBC). The GBC is the only passage in the model through which the Lakes are connected to the Atlantic Ocean. The model-calculated tidal sea surface elevations and circulation agree reasonably well with the observations made in the lakes. The nested-grid system in the second experiment is forced by tides, wind stress, surface heat flux, and river discharge. The residual (non-tidal) circulation in the lakes calculated from the model results demonstrates that the brackish near-surface waters flow seaward from the Lakes into the ocean and deep salty waters flow landward from the ocean into the Lakes, which is the typical two-layer pattern of the estuarine circulation. Due to strong vertical mixing in the Great Bras d'Or and Barra Strait, temperatures are more vertically uniform over these areas than other areas.

1C1.6

Water thermodynamics on the way to forming Polar Mesospheric Clouds: A study of by collocated ACE-FTS and OSIRIS observations

A.Y. Zasetsky [1] , S. Petelina [2] , C.D. Boone [1] , I.L. Galkina [1] , J.J. Sloan [1]
[1] University of Waterloo
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The properties of the polar mesosphere, in particularly water in both the gaseous and condense phases, are believed to be sensitive indicators of climate change. The remote sensing observations made by two Canadian instruments – the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) on the SciSat satellite and the Optical Spectrograph and Infrared Imager System (OSIRIS) on the Odin satellite – provide unique opportunity to study the thermodynamics of water in the polar mesosphere. By using the coincident ACE and OSIRIS measurements we examine the interrelations and consistency between the water vapor density, temperature, and microphysical properties of ice particles that form Polar Mesospheric Clouds (PMC). This combination of mesospheric characteristics, retrieved simultaneously, can greatly improve our understanding of the processes responsible for the formation and evolution of PMCs. We present the results of a combined ACE and OSIRIS study of the polar mesosphere in the presence of PMCs for the seasons of 2004 and 2005. A novel technique for the temperature estimations from the bandshape of the Ice O-H stretch mode is also discussed.

4B4.3

Simulated changes in the extratropical Southern Hemisphere winds and currents

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The results from 12 global climate models show a remarkably consistent strengthening and poleward shifting of the zonal wind stress through the 20th and 21st centuries at extratropical Southern Hemisphere latitudes. Changes in the zonal circulation of the ocean in the region are broadly consistent with the changes in zonal wind stress. In particular, the climate models simulate a strengthening and a poleward shift of the Antarctic Circumpolar Current. The strengthening of the zonal wind stress also results in intensifying northward Ekman transport across the Antarctic Circumpolar Current which, in the unblocked latitudes of Drake Passage, implies increasing southward geostrophic transport in the ocean below about 2000~m. Zonal wind stress changes such as these may be expected to enhance the meso-scale eddy activity in the Southern Ocean.

4B2.2 **INVITED / INVITÉ**

Modeling and observational studies off the entrance of Juan de Fuca Strait

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The interaction of strong tidal and estuarine flows in Juan de Fuca Strait with rapidly changing bathymetry and along-shore currents off western Vancouver Island and Washington make the entrance to the Strait a very dynamic region. In summer, it is also home to the Juan de Fuca (or Tully) Eddy, a feature that recent studies suggest is an initiation site for the toxigenic phytoplankton Pseudo-nitzschia that impact shellfish along the Washington coast. As part of ECOHAB PNW, a project funded by the Ecology and Oceanography of Harmful Algal Blooms program, data collected from five cruises have been combined with bio-physical model simulations using the Regional Ocean Modeling System (ROMS) to better understand the dynamics and ecology of the region. This talk will describe select project results including the generation of internal tides at the entrance to the strait and the role that winds, estuarine flow, and tides play in the formation of the eddy.

3B2.7

Amplification of the mesospheric diurnal tide in a doubled CO2 atmosphere

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The impact of doubled CO2 on the vertically propagating migrating diurnal tide in the mesosphere is studied using the Canadian Middle Atmosphere Model (CMAM), a coupled chemistry-climate model that extends from the Earth's surface to the lower thermosphere. A linear tidal model forced by the tidal heating from the CMAM is used to attribute cause and effect. The CMAM results exhibit a tidal temperature amplitude increase of up to 2 K in the equatorial upper mesosphere. This is attributed primarily to an increase in tropospheric solar heating which results from an increase in water vapour. Changes in stratospheric solar heating, radiative damping, tropospheric latent heating, background atmosphere, and clouds are found to have little impact.

2B4.2

An Assessment of Seasonal Forecast Skills from the Canadian HFP

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The Canadian historical forecasting project (HFP) uses four global models to produce a series of seasonal hindcasts. A skill assessment of seasonal hindcasts is carried out both in a deterministic and probabilistic framework. Three methods: the count method, the Gaussian fit method, and the statistically improved technique, are employed to produce probability forecasts for three categories (below, near and above normal). Commonly used verification measures, such as the mean square skill score, the Brier skill score, and the relative operating characteristic and its skill score are analyzed for the individual models and a multi-model ensemble. The latter takes uncertainties of both initial conditions and model errors into account. Our analyses demonstrate the superiority of multi-model ensemble to the single model ensembles. The raw Gaussian fit method is generally better than the count method, while the statistically improved technique may not always be beneficial.

2C4.4
The life cycles of the AO and NAO: an observational study
XiaoJing Jia , Jacques Derome , Hai Lin
(Presented by / Présenté par ***XiaoJing Jia***)
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This study investigates the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) on an intraseasonal time scale and compares them. The daily NCEP/NCAR reanalysis data spanning 51 boreal winters are used.

The AO and the NAO are similar in many aspects but several differences between them are also observed, such as the fact that the negative NAO has a sharply decaying frequency distribution of lifetimes. This feature is not found for the negative AO. We propose that this difference is related to the influence coming from blocking events located over different geographical areas. The setup processes for the two polarities of the AO are more nearly anti-symmetric than those of the NAO. The positive NAO shows a wave train signal over the Pacific-North American region during the setup phase while the negative NAO is found to develop more locally over the northern Europe-North Atlantic area.

Calculations of the wave-activity flux reveal that the flux for the AO is primarily in the zonal direction and penetrates into most of the northern Eurasian continent. However the wave activity flux for the NAO is mostly concentrated over the North Atlantic. Results of the vorticity budget analysis demonstrate that during the setup stages the high-frequency transients contribute to the growth and maintenance processes. The low-frequency transients help setup the AO and the NAO events but at the mature stage, they contribute to damp these events.

Predictions experiments over two-week periods are conducted with a global model to determine the predictability level of the AO and NAO patterns of both polarities.

4B2.6
Simulating Circulation on the Scotian Shelf using a Sigma-Coordinate Model
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Circulation on the Scotian Shelf in 2001 is simulated using the Princeton Ocean Model. We use a nested-grid setup, adapted from the operational circulation forecast system known as DalCoast. The outer model covers the northwest Atlantic and is barotropic, while the inner model, covering the Scotian Shelf, calculates both barotropic and baroclinic circulations. Both models are forced by winds and sea-level atmospheric pressure from the numerical weather prediction model GEM (Global Environmental Multiscale). Depth-averaged currents and sea surface elevation from the outer model, as well as those from the tidal prediction model Tidecor, are used as lateral open boundary inputs for the inner model. Additional open boundary inputs include monthly climatologies of ocean temperature and salinity, and monthly mean currents from a three-dimensional ocean circulation model of the northwest Atlantic. A recently developed data assimilation method, known as spectral nudging, is used to constrain model variables to stay close to climatologies on the longer (*O*(months)) timescales while allowing them to evolve freely on shorter time scales. Model results are compared to observed sea surface elevation from coastal tide gauges, and observed currents and bottom pressure in the vicinity of Sable Island.

4DPA8.2
Implementation of Web Mapping Tools for Monitoring Water Quality in Ria Formosa Coastal Lagoon using UMN MapServer

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In recent years, monitoring efforts had evolved in a way that results from different sampling techniques and from models must be integrated in order to produce a complete picture of the system. Several scientific monitoring and research efforts focused on Ria Formosa, Portugal, coastal lagoon system have resulted in a large amount of data for this system. Data have several different topologic natures such as point data, sonde path profiles, Eulerian and Lagrangian model outputs. The temporal spread of the data is also important. Data obtained from the campaigns are usually spaced by days or months, while results from models are spaced by the model time step, usually of the order of seconds. These different time scales result in difficulties for the storage and handling of data. To enable a complete understanding of the system it is necessary to integrate the different types of data, this will be particularly useful to understand the human impacts in the system and also to perform historical change and environmental trend analyses.

This presentation will provide an overview of the application development using MapServer, MSAccess, Java, Visual Basic and Active Server Pages to manage data in Ria Formosa. Our intent is to continue developing this interactive Web-based GIS by MapServer and to design geodatabase using PostgreSQL that will allow the user to filter data by sampling sites, parameters, field campaigns and specify time periods of interest. This application will also allow the user to represent model results and to compare them with field measurements.

2DPA6.4
Large-Scale Dynamics of the MLT: An analysis using the extended Canadian Middle Atmosphere Model
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The extended Canadian Middle Atmosphere Model is used to investigate the large-scale dynamics of the mesosphere and lower thermosphere (MLT). It is shown that the four-day wave is substantially amplified in southern polar winter in the presence of instabilities arising from strong vertical shears in the MLT zonal mean zonal winds brought about by parameterized non-orographic gravity wave drag. A weaker four-day wave in northern polar winter is attributed to the weaker wind shears that result from weaker parameterized wave drag. The two-day wave also exhibits a strong dependence on zonal wind shears, in agreement with previous modeling studies. In the equatorial upper mesosphere, the migrating diurnal tide provides most of the resolved westward wave forcing, which varies semi-annually in conjunction with the tide itself; resolved forcing by eastward travelling disturbances is dominated by smaller scales. Non-migrating tides and other planetary-scale waves play only a minor role in the zonal mean zonal momentum budget in the tropics at these heights. Resolved waves are shown to play a significant role in the zonal mean meridional momentum budget in the MLT, impacting significantly on gradient wind balance. Balance fails at low latitudes as a result of a strong Reynolds stress associated with the migrating diurnal tide, an effect which is most pronounced at equinox when the tide is strongest. Resolved and parameterized waves account for most of the imbalance at higher latitudes in summer. This results in the gradient wind underestimating the actual eastward wind reversal by up to 40%.

3DPA2.15
The validation of the "snap shot" approximation of the radiosonde measurements
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The six minute time resolution of the HIMAP model was used to simulate the vertical profile of temperature, pressure and relative humidity for a chosen set of levels for the Maniwaki location. Two sets of differences of radiosonde and HIMAP vertical profiles were produced. The first set used HIMAP vertical profiles for the sonding launch time. The second set used HIMAP values for a different time for each level, according to the estimated altitude of the radiosonde during its lifting through the atmosphere. A comparison of these two sets of data gives an estimation of how valid the "snap shot" approximation of radiosonde measurements are for the different ascending time rate and weather conditions.

1B3.3
New discoveries in geostrophic turbulence phenomenology: an inverse baroclinic kinetic energy cascade
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The inverse kinetic energy cascade is one of the most intriguing, counter-intuitive phenomena of 2D turbulence, with small-scale flow somehow organizing to form larger scale flow features. In rotating turbulent flows with vertical density stratification (geostrophic turbulence), the extra degrees of freedom introduced by the hierarchy of baroclinic modes (i.e. the vertical structure of the horizontal currents) leads to more complex cascade phenomenology. Traditionally the inverse cascade has been attributed *only* to the barotropic mode (depth independent flow), while the total energy in higher baroclinic modes converge to their respective deformation radii, and simultaneously toward the barotropic mode. We discovered that the *baroclinic* kinetic energy in two-layer geostrophic turbulence also cascades upscale. For the most "oceanic case" (i.e. surface intensified stratification) this inverse cascade is actually much stronger than the well-

know barotropic inverse cascade. These results are related to recent observations of the cascade at the oceanic surface. We also speculate on the relevance to zonal jets in the ocean.

3B4.3

The role of atmospheric blocking in the context of large-scale climate modes

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On occasions the prevailing westerly circumpolar flow in the extra-tropics is suppressed by the presence of a quasi-stationary high pressure system referred to as atmospheric blocking. Both, the relatively long life-time (days to weeks) and the predilection for the Northern Hemispheric Atlantic-European and Pacific sector prompts considerations of a possible linkage between blocking and the major sources of seasonal climate variability such as the North Atlantic Oscillation (NAO) or the Pacific North American pattern (PNA). Several statistically-based studies highlight in particular the correlation between blocking over the Atlantic and the negative NAO phase. A dynamical explanation of the core/relation of these phenomenons is still open and not well understood. Here a recently developed blocking indicator (2D distribution, 6 hourly time resolution) is applied on the entire ERA-40 ECMWF-reanalysis period (1958 - 2001) for the Northern Hemisphere. The focus is set on the Atlantic and Pacific basin for the NAO and PNA respectively. In this study we adopt a twofold strategy. First a statistical composite analysis indicates significant correlation (anticorrelation) between blocking occurrence in the North Atlantic/Pacific and the negative (positive) NAO/PNA phases. Second an event-based approach is adopted that identifies every single blocking track during the opposed pattern phases. Distinctively different blocking tracks and hence different genesis and lysis regions are found between the opposed phases of the climate variability patterns in each basin. Furthermore, to get some insight whether blocking events can modify/determine the pattern index values, these index values are investigated during every individual blocking track. Evidence is given, suggesting that in particular long-lasting blocking events might be of importance in the determination of the negative NAO phase. In comparison, these findings do not hold for the Pacific sector and the PNA index which indicates that here other factors are important. Together, the two approaches shed some new light on the variability of large-scale climate modes and their relation to atmospheric blocking.

1C4.3

Variability and Change in the Canadian Cryosphere: a Canadian contribution to the IPY "State and Fate of the Polar Cryosphere"

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This presentation will provide an overview of a planned network proposal to provide a Canadian contribution to the IPY-endorsed "State and Fate of the Polar Cryosphere (IPY proposal 105)" activity supported by the World Climate Research Programme (WCRP) Climate and Cryosphere (CliC) project as a framework for observing and understanding the current state of the cryosphere, and its associated past, present and future variability and change in time and space. The main objectives of the network proposal are to: (1) provide information on the current state of the Canadian cryosphere during IPY as a contribution to the IPY snapshot; (2) place current cryospheric conditions in the context of the historical record to document the magnitude of changes since IGY 1957; (3) characterize and explain the observed variability in cryosphere and climate; and (4) improve the representation of the cryosphere in Canadian land surface and regional climate models for a better understanding of the cryosphere and for better simulation of its current and future states. These activities will provide improved knowledge of cryospheric changes in the Canadian Arctic, and improved baseline climate and future climate projections for

impact analyses. The proposal also includes a multi-disciplinary post-IPY activity (workshop and report) to provide a synthesis of variability and change in the Canadian cryosphere and to examine the ecological and human implications of observed and anticipated changes.

3C2.1
Long-term changes of atmospheric blocking and their contribution to recent large-scale trends

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An atmospheric blocking event can be characterised by a disruption of the prevailing westerly circumpolar flow in the extra-tropics due to a persistent quasi-stationary high pressure system. Since blocking exhibits a preferred spatial distribution, a significant and sustained trend in its amplitude and/or location could impact upon the large-scale signature of climate change.

Here a systematic trend analysis is undertaken using a recently developed dynamically-based blocking indicator, based upon quasi-stationary, potential vorticity anomalies at tropopause level. The investigation is conducted over the whole ERA-40 ECMWF-reanalysis period (1958 - 2001) on the Northern Hemisphere. The basis for the blocking trend analysis is the long-term blocking climatology. Seasonal composites generally agree with already published blocking climatologies but give in addition the possibility to capture dynamically relevant blocking characteristics.

Using this blocking climatology linear trends for the entire ERA-40 period are calculated on a monthly basis at every grid point separately. The results point to significant negative blocking trends over Greenland (North Pacific) during the boreal winter (spring) season. Evidence is shown that the detected blocking trends can be related to changes in the number of blocking events rather than changes in their final life time. In addition the strong negative blocking trends over Greenland correspond to trends of various meteorological variables (e.g. tropopause height, geopotential height, sea level pressure). In particular wintertime tropopause height trends are associated with an opposed trend pattern situated south of the trend pattern around Greenland. Our results suggest that atmospheric blocking contributes seminally to establish the tropopause height trend. Furthermore it is indicated that trends of high-frequency anomalies (synoptic scale) are linked to the neighbouring tropopause trend signal to the south.

2B4.5
The variability of the surface air temperature over North America

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A Principal Component analysis was performed on the winter mean-monthly surface air temperature (SAT) over North America to identify the principal spatial structures (modes) in the NCEP reanalysis data (1948-1998). The first two winter modes are related to the North Atlantic Oscillation (NAO) and the Pacific North American (PNA) pattern. Lagged regressions between the North American SAT modes and the Northern Hemisphere sea surface temperature (SST) were computed. The results show that one continental SAT mode leads the tri-pole SST anomaly pattern of the North Atlantic Ocean. The second SAT mode lags the eastern tropical SST anomaly, associated with ENSO, through the winter.

A similar analysis is conducted on the seasonal forecasts performed over 31 winters (1969 – 1999) as part of the Historical Forecasting project to see if the forecast models capture the influence of the SST on the continental SAT found in the NCEP data.

2C4.3
Can fall Siberian snow cover force a response in Northern Hemisphere winter climate?

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Observational studies have highlighted potential relationships between fall Siberian snow cover and Northern Hemisphere winter climate. Theory and modelling results suggest the physical mechanism may involve Siberian snow cover inducing anomalous upward wave activity from the troposphere into the polar stratosphere. However, debate currently exists as to whether, and to what extent, regional snow cover anomalies can force such large scale planetary-wave responses. We present results from snow forcing experiments run on the GFDL AM2 atmospheric model. Our ensemble integrations employ prescribed high and low snow cover over Siberia during the Northern Hemisphere fall and winter seasons. We investigate how the atmosphere evolves on daily to seasonal timescales in response to these boundary forcings. In particular, we assess to what extent the troposphere and stratosphere are coupled during early winter in response to the snow.

1B2.8
An improved method for forecasting precipitation phase
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Precipitation phase and transitions between phases has long been an operational forecast challenge. Current guidance, available via numerical weather prediction (NWP) model post processing algorithms [e.g. model output statistics (MOS)] show little skill. Improving the accuracy of operational precipitation phase transition (PPT) forecasts provides many social and economic benefits and motivates an investigation of alternative techniques. During the course of this investigation, new insights into the physics of the PPT problem are also provided.

Composite vertical profiles of temperature and moisture for the six possible PPT types are constructed. This composite analysis reveals the subtle differences among transition environments and reinforces the inherent complexity of the forecast problem. Statistical methods were employed to develop an alternative PPT forecast tool. Rawindsonde (RAOB) data were attained for 17 sites across the United States based on the climatological likelihood of freezing precipitation. The soundings launched at the onset of an observed phase transition were employed in a logistic regression. Principal component analysis isolated the most relevant factors in identifying the six possible transitions. These factors are related to the physics of PPT. The new tool is shown, using measures-based verification, to provide substantial improvement relative to the current PPT guidance obtained from MOS precipitation type. Operationally, the technique can be applied in either diagnostic or forecast contexts (using observed or model soundings, respectively) and is therefore of direct practical interest.

1C2.1
Locality and forecast skill - implications for the future of operational forecasting
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Studies in the mid-1990's investigated whether any forecast advantage that can be obtained through local familiarity is superseded by the leveling effect of information available to all forecasters through interpretation of observations and numerical weather prediction (NWP) data. Data availability has continued to increase and discussions have now emerged regarding whether it might be fiscally more prudent to allocate scarce resources at the regional rather than local scale within forecast entities such as the U.S. National Weather Service.

The prior studies examined routine forecasts made in collegiate venues rather than high-impact weather forecasts generated by professionals trained to forecast at the national scale. Here, significant severe weather (hail, winds and tornadoes) forecasts from the NOAA/Storm Prediction Center and heavy precipitation forecasts (greater than 12.5 mm in six hours) from the NOAA/Hydrometeorological Prediction Center are examined. The results regarding a transition of forecast services from local to regional scale are conclusive:

1) Heavy precipitation forecast skill would degrade by the equivalent of 6-10 years, with the impact most apparent in the warm season, when convection dominates.
2) Significant severe weather forecast skill would decrease 15 to 26%, depending on the climatological frequency of severe weather.
3) Significant tornado forecast skill would diminish substantially in areas with relatively less frequent severe weather.

The results affirm that local knowledge can be an important contributing factor when highly skilled forecasters construct forecasts. Since gains in skill of high-impact forecasts are hard-won, prudence argues that those practices that facilitate the greatest skill be retained.

4DPA6.20
Particle size change from heterogeneous oxidation by OH radicals of model organic aerosols
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OH oxidation reactions of gas-phase organics have been extensively studied, yet little research has focused on the oxidation of organic aerosols of atmospheric relevance. A recent laboratory study by Molina et al. (2004) has indicated that volatilization of gas-phase products arising from OH oxidation of organic films is sufficiently efficient that heterogeneous oxidation may be an important sink for atmospheric organic aerosols. In this study we report the first size changes observed arising from OH oxidation of model organic aerosols. The experiments are conducted using a Tandem Differential Mobility Analyzer (TDMA) and a reaction flow tube. Hydroxyl radicals were produced by photolysis of ozone with UV light in the presence of water vapour and their steady-state concentration was quantified using Chemical Ionization Mass Spectrometry. The size changes from OH oxidation for stearic acid and other model organic aerosols will also be presented. Our results indicate that heterogeneous oxidation may be an important modification process and sink for atmospheric organic aerosols.

3DPA3.16
Applicability of Davenport Roughness Classes in Wind Energy Resource Assessment
David Laporte
(Presented by / Présenté par ***David J. Laporte***)
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This poster presents ongoing thesis research on the use of Davenport Roughness Class guidelines for assigning direction-dependent surface roughness (z_0) lengths at monitoring tower locations for power prediction in the wind energy industry.
Its aim is to show that empirically derived z_0 calculations from profile analysis are often much greater that those which might be estimated through the use of the Davenport guidelines. This could lead to serious underestimation of the local wind resource at sites where guidelines are used in place of direct measurement.

4C2.2 **INVITED / INVITÉ**

Variability of coastal ocean processes along the east and west coast of India

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A three-dimensional orthogonal curvilinear-grid Princeton Ocean Model (POM) has been implemented to study the circulation, temperature and salinity off the east and west coasts of India. The POM has been configured for the southwest coast of the Indian peninsula, from 7.5^{o}N to 23.5^{o}N, covering the entire west coast. The breadth of the region (distance from the coastline to the western open-sea boundary) is about 450 km parallel to the coast. Similarly, the model analysis area covers along the east coast from 13^{o}N to 22^{o}N with an offshore distance of 300 km. The resolution in the east-west direction varies from 1-5 km, finer near the coast, and 10-15 km in north-south direction. The models use the bottom topography derived from ETOPO2. The time step for the barotropic mode is 12 s and baroclinic mode is 480s.The effect of freshwater outflow from various river systems along the coast is also incorporated in the models.
The experiments are initially aimed to carry out model simulations on climatological scale, before proceeding for model evaluation on real-time basis. The model is forced with monthly climatological winds of COADS (da Siva et al., 1994). The model is also forced with the daily surface fluxes by linearly interpolating SST (Reynolds et al., 2002) from monthly to daily scale. The model is initially spun-up for 30 days in the diagnostic mode. The model is further integrated in the prognostic mode for all the months using initial fields from the diagnostic run and the model simulations are then studied and analyzed. The model is able to capture and resolve the coastal processes and offers an insight to the role of river discharge and the temperature inversions. The model simulates the formation of Lakshadweep High and Low off southwest India during winter and summer monsoon respectively. These high and low propagate westwards for about two months as a consequence of westward propagating Rossyby waves radiated by Kelvin wave propagating poleward along the western margin of the Indian subcontinent. It is also studied the effect of coastally trapped Kelvin wave on the circulation. The response of the coastal ocean is seen on different time-scales using the real-time winds for 2000 and 2003. The model simulations could show that the shallow mixed layer depth and weak vertical thermal stratification to be susceptible for upwelling. The model simulated SST is fairly in good agreement with the corresponding analyzed in-situ and satellite SST imageries.

1DPA1.22

A technique to optimize minimum temperature forecasts
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Accurate forecasts of minimum temperature are important in a variety of forecast contexts including: aviation safety, precipitation type, heating and cooling demand for the energy sector, agricultural interests, heat stress and wind chill. Despite these requirements, providing accurate minimum temperature forecasts can be a major challenge, particularly during the cool season, owing to the complex interaction of factors that effect temperature. For three stations in southwestern Ohio, NOAA/National Weather Service (NWS) minimum temperature forecasts studied over a ten year period were found to depart from observations by more than 3°C more than 20% of the time. Examination of the most egregious of these forecast errors revealed that they arise in a wide variety of settings.

The problem is addressed using sophisticated nonlinear techniques: logistic multiple regression and artificial neural networks (ANN). A set of inputs was identified and dimensionality was reduced using factor analysis. Separate development and test datasets were constructed from the available data. A logistic multiple regression was used to identify the probability of an optimal forecast; this information, together with other inputs, were then used to train an ANN to “correct” the NWS forecast. The corrections were evident across the spectrum of forecast errors, with

busted (optimal) forecasts decreasing (increasing) by 41% (10%). Additionally, sensitivity analysis of the network responses revealed human forecast biases, suggesting that the approach may also prove valuable as a forecaster training tool.

3C2.3
Detecting local climate change: linking weather system frequency to synoptic scale meteorology.
Brian R. S. Horton [1] , Shawn J. Marshall [2]
(Presented by / Présenté par ***Brian Horton***)
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Detection of local-scale climate change is typically based on statistical analysis of single surface variables. Such techniques fail to account for the relationships between weather variables that create different meteorological conditions. Local-scale climate projections are also impaired by low resolution of circulation models, which tend to poorly simulate surface variables relative to skill in simulating large-scale circulation patterns. This research develops a new tool for detection of local climate change based on daily multivariate classification of weather systems. Monthly frequencies of each weather system are used to describe climate variability and trends in Calgary, Alberta for the period 1953-2004. A five year sub-sample of observations was used to characterize daily weather systems using principal components analysis and cluster analysis. Hourly observations of temperature, dew point temperature, pressure, specific humidity, and north-south and east-west components of wind speed are summarized as daily de-trended average, standard deviation, trend, range and maximum hourly change. All daily data are then normalized for the 52 years to remove seasonal signals. After training weather systems with the sub-sample, classification of all 52 years is performed using discriminant function analysis. To assess the utility of this method in climate change detection, we analyze relative frequency of weather classes as a function of synoptic-scale meteorological conditions (e.g., monthly El Nino Southern Oscillation Index; the Pacific Decadal Oscillation; 500-mb height over Calgary). If this link can be established, it provides a new and insightful basis for regional climate change impact studies that are derived from larger-scale GCM projections.

1DPA2.9
Using ACE Measurements to constrain parameterizations of tropical convection
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We are quite familiarized with the tilted structure of oceanic and atmospheric baroclinic jets when plotted as a function of depth or pressure, but there is no evident reason for such tilting. In this work we study the vertical alignment of both oceanic and atmospheric streams using in-situ measurements as well as numerical model outputs. It is shown that the baroclinic jet may be aligned either with depth or with density but not simultaneously with both. The observations indicate that streams are vertically aligned only when observed in isopycnic coordinates (isentropic coordinates for the atmosphere), but only in a natural system, a system normal to the current axis. The alignment is also clear in the geostrophic velocity fields inferred from hydrographic data, in either the coastal or the deep ocean. We propose that the density alignment is the result of the inertial character of intense oceanic and atmospheric streams.

3DPA1.8
Implementation of the Monte Carlo Independent Column Approximation in GEM
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A new approach for radiative transfer, the Monte Carlo Independent Column Approximation (McICA), has been implemented in GEM. The appeal of the McICA is that it allows very flexible descriptions of unresolved optical properties and yet provides unbiased, relative to ICA, estimates of radiative fluxes. These attributes are possible without much increase in computational time due to the use of Monte Carlo sampling. However, the sampling does produce stochastic noise in the radiative fluxes which potentially may affect other components of GEM. This poster summarizes tests to examine the impact of "noise" generated by McICA on GEM.

2C4.6
The Nonlinear Transient Atmospheric Response to Tropical Forcing
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The El Nino and La Nina are well known to be the leading sources of seasonal forecasting skill in the extra-tropics. Yet the nonlinear response to the implied tropical heating and cooling is not yet well understood. This study is aimed at shedding some light on this nonlinearity. Ensemble integrations using a primitive equation dry atmospheric model were performed to investigate the atmospheric transient response to a tropical heat source. Three sets of experiments were conducted: a control run with climatological forcing that maintains time mean flow and transients, and two perturbation runs with anomalous tropical thermal forcings that resemble an El Nino and a La Nina forcing, respectively. Each set consists of 50 integrations of 30 days under the same forcing but from different initial conditions taken from observed daily atmospheric states. The daily difference between the ensemble mean of the perturbation run and that of the control run represents the response to the anomalous forcing. The wave activity flux associated with the time evolution of the response was calculated and analyzed. The emphasis has been placed on the nonlinearity of the response. It is found that the 550 mb height positive reponse in the North Pacific of the La Nina run is notably stronger than the negative response of the El Nino run as early as five days after the beginning of integration. The nonlinearity increases with time. After about two weeks, the responses in the North Atlantic for the La Nina and El Nino cases have a similar pattern with the same polarity. Mechanisms responsible for this nonlinearity of the response are discussed.

3B4.6
Intraseasonal Variability in a Dry Atmospheric Model
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The Madden-Julian Oscillation (MJO) is a dominant mode of variability in the tropical atmosphere. Changes of its amplitude and phase influence the weather not only in the Tropics but also in the middle latitudes. A convincing explanation of how the MJO gets excited and how it is maintained remains elusive. In most existing theories, moisture and convection are considered crucial to the MJO since the tropical latent heat serves as an energy source to support the large-scale oscillation against damping. In this study, a long integration of a primitive equation dry atmospheric model with time-independent forcing is analyzed. Significant variability on the intraseasonal time scale (30-50 days) is found in the Tropics that shares many features with the MJO. It is argued that interactions between the tropical and extratropical flows are responsible for the intraseasonal variability in this model.

1B2.6

Analysis of Composite Soundings Parameters Associated with Severe and Tornadic Thunderstorms in Central Alberta

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Detailed composite profiles of temperature, dewpoint and wind are constructed for severe non-tornadic thunderstorms and tornadic thunderstorms that affected central Alberta during the period 1967-2000. Storms were divided into three categories consisting of 13 Non-Tornado severe thunderstorms which produced hail ≥ 3 cm in diameter but no reported tornadoes, 61 Weak Tornadoes (F0-F1), and 13 Significant Tornadoes (F2-F4). All three profiles showed potential instability through most of the sounding. The Non-Tornado composite had the greatest value of CAPE (1250 J kg^{-1}), the Weak Tornado composite the lowest (540 J kg^{-1}), while the Significant Tornado composite was in the middle (850 J kg^{-1}). The hodograph for the Significant Tornado composite was similar to that for supercells in Alberta with large low-level veering and strong southwest winds aloft. The hodograph for the Weak Tornado events showed weak low-level veering. The Non-Tornado hodograph was closer to the multicell cell storm pattern for Alberta, having nearly unidirectional winds. The Significant Tornado composite had the strongest 900-500 mb bulk shear (~4 m s^{-1} km^{-1}) followed by the Non-Tornado (~ 3 m s^{-1} km^{-1}) and Weak Tornado (~2 m s^{-1} km^{-1}) composites. The Significant Tornadoes had 0-3 km storm-relative helicity of 156 m^2 s^{-2} whereas the Non-Tornado and Weak Tornadoes had much lower values of about 80 m^2 s^{-2}. Precipitable water was greatest for the Significant Tornado composite at 26 mm compared to 21 mm for the other two cases.

1B4.2

Storm Studies in the Arctic (STAR): A CFCAS Major Initiative

John Hanesiak [1], Ron Stewart [7], Kent Moore [6], Peter Taylor [5], David Barber [1], Gordon McBean [4], Bohdan Kochtubajda [3], David Hudak [2]
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Storms and their related hazards over the Arctic have profound effects including loss of life and impacts on all life forms, industry, transportation, hunting, recreation, as well as on the landscape (terrestrial, sea ice and ocean). Over the past few decades, there is some evidence that the occurrence of such storms have increased and further changes are expected with anticipated climate change.

STAR (Storm Studies in the Arctic) has been funded by CFCAS to examine these Arctic storms. STAR is concerned with the documentation, better understanding and improved prediction of these storms and their related hazards in the Arctic. This includes their modification by local topography and land-sea-ice-ocean transitions as well as their impact on the local communities. Information from STAR will also contribute to improved assessment of meteorological hazards relative to a changing climate.

To make progress on these critical issues, STAR will focus on extreme weather events in south eastern Nunavut. In particular, STAR will involve a major field campaign based out of Iqaluit, Nunavut in the autumn-winter of 2007/08 during the International Polar Year (IPY). Special

measurements include the use of a research aircraft (including dual polarization Doppler radars), surface-based Doppler radars, wind profiler systems, special weather balloon launches, micrometeorological towers, profiling microwave radiometers and detailed surface precipitation measurements.

4C1.1 **INVITED / INVITÉ**

Analyses of Satellite Observations of Tropospheric Composition

Randall Martin [1], *Aaron van Donkelaar* [1], *Rongming Hu* [1], *Bastien Sauvage* [1], *Ian Folkins* [1], *Peter Bernath* [2]
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Nascent satellite observations are providing unprecedented information on tropospheric composition at the global scale. A challenge is to quantitatively interpret these observations to address existing scientific issues. This talk will analyze measurements of trace gases and aerosols from the MODIS, MISR, SCIAMACHY, OMI, and ACE satellite instruments using a chemical transport model and in-situ measurements to provide insight into particulate matter concentrations in the lower mixed layer, aerosol single scattering albedo, and emissions of nitrogen oxides from surface sources and lightning activity.

2B3.6

Inferring Regional Carbon Sources and Sinks by Merging Ground-based and Atmospheric Observations

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Terrestrial sources and sinks of carbon have primarily been understood on local (<10 km) and global scales (>1000 km), with a large knowledge gap at intermediate, regional scales. One of the key difficulties has been the inability to merge atmospheric observations over the continent—which contain signals of regional carbon fluxes—with biospheric observations on the ground. We propose a modeling framework in which the ground-based observations can be combined with atmospheric constraints, as well as quantitatively accounting for model uncertainties. We illustrate application of the framework with examples in the U.S. and Canada and identify existing challenges that need to be overcome in order to make future progress.

1C4.2

Modelling the soil thermal regime at high latitudes

Diana Verseghy
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Energy and moisture fluxes at the land surface are strongly affected by the soil climate, which in turn is governed by the flows of heat and water within the soil. At high latitudes and altitudes the latter are complicated by seasonal phase changes of water, and by the development of an active layer in permafrost or the penetration of the frost table in temperate climates.

This presentation will examine the effect of various features of the parameterization of the soil in CLASS (Canadian Land Surface Scheme) on the surface and subsurface energy and moisture balances. Practical aspects of the discretization of the soil profile will be discussed, the effect of the thermal and hydrological properties of organic soils will be explored, and the influence of surface slope at the low sun angles characteristic of high latitudes will be examined.

3DPA3.2
Spatial-Temporal Evolution of the 2005 June Cyclonic storm events in southwestern Alberta using the Foothills Climate Array meteorological network
Shannon Fargey , Shawn Marshall
(Presented by / Présenté par ***Shannon E. Fargey***)
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Record rainfall totals for southern Alberta in June, 2005 resulted in extensive flooding, causing hundreds of millions of dollars damage and the loss of four lives. The flooding was triggered by a sequence of three upslope cyclonic storms in the region. We are analyzing the spatial structure of each storm system and its interaction with the topography, based on data from the Foothills Climate Array (FCA) meteorological network. The FCA is a network of 282 meteorological stations (HOBO tipping bucket rain gauge and Veriteq temperature-humidity loggers) located in southwestern Alberta, with a spatial coverage of 24 000 km^2. The instruments are positioned along 12 west-east transects that traverse the eastern slopes of the Canadian Rockies, extending into the interior of the prairies 40 km east of Calgary. Total storm precipitation, storm duration, mean storm intensity, and maximum storm intensity are quantified for each station in the array. Spatial correlation analysis is used to examine whether the spatial autocorrelation varied between each of the three storm events and to elucidate the effect of altitude on the variability of precipitation received in the study region. In addition, between-site temporal correlation analysis provides a picture of how the cyclonic storm events moved over the study area. The network samples a greater diversity of elevation and surface environments than existing (Environment Canada, Alberta Environment) meteorological networks. The detailed structure of the FCA network provides a new perspective on precipitation processes and mesoscale rainfall variability in the complex terrain of southwestern Alberta.

2B2.2
Cloud radiative smoothing and its bearing on climate modelling
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Confidence in global climate models (GCMs) is bolstered by using global datasets to assess properties of their simulated clouds. Global datasets generally come from satellite observations. Because satellites are expensive, most weather- and climate-related satellites are equipped with passive radiometers. While retrieval of cloud properties from passive satellite imagery is fraught with difficulties, we have no choice but to use them. A particular difficulty that becomes more problematic as the representation of clouds by GCMs becomes more sophisticated has to do with horizontal transport of photons within variable (i.e., all) clouds. Since cloud properties are retrieved using 1D radiative transfer theory, the diffusion of information affected by horizontal transport is systematically neglected. This impacts the retrieval of distributions of cloud optical properties thereby making it difficult to assess and construct GCM cloud parametrizations. It is well known that horizontal transport acts to suppress details of cloud structure at scales smaller than about 300 m. As such, it is responsible for breaks in scaling that are ubiquitous to radiance wavenumber spectra and structure functions. It is argued here that the magnitude of observed radiance scale breaks cannot be explained by radiative smoothing alone. It seems essential that relevant cloud structures exhibit a corresponding scale break at, or near, radiative smoothing scales thereby augmenting the effects of radiative smoothing.

This poster will demonstrate how various cloud structural characteristics impact shortwave radiance wavenumber spectra. Calculations are made using cloud forms generated by a bounded-cascade model and a 3D Monte Carlo radiative transfer algorithm.

2B2.1
Remote Sensing of Aerosol Single Scattering Albedo from Space-based Observations

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The lack of detailed knowledge of aerosol single scattering albedo (ω_0), the fraction of intercepted radiation that is scattered, is one of the largest uncertainties in climate forcing assessments. In this study, we retrieve the global distribution of columnar single scattering albedo (ω_0) by taking advantage of the high sensitivity of satellite measurements at ultraviolet channels by the Total Ozone Mapping Spectrometer (TOMS) to both aerosol optical depth and ω_0, and the high sensitivity of satellite measurements at visible channels by the Moderate Resolution Imaging SpectroRadiometer (MODIS) to aerosol optical depth. A linearized discrete ordinate radiative transfer model (LIDORT) is used to calculate the local ω_0 that reproduces the TOMS aerosol index, when constrained by MODIS aerosol optical depth and by relative aerosol vertical profiles from a global chemical transport model (GEOS-CHEM). The simulated aerosol profiles are evaluated with lidar measurements of aerosol extinction. The retrieved ω_0 at 360 nm is near 1 over the remote ocean, in contrast with values of 0.75 to 0.9 over regions dominated by biomass burning and mineral dust aerosols. The expected retrieval uncertainty is 15 percent. We validate our retrieval with measurements from the Aerosol Robotic Network (AERONET) and find significant agreement. The correlation coefficient, slope and intercept are 0.75, 0.93 and 0.08 respectively.

1DPA3.1
Postglacial climates of the Canadian Arctic
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We review current knowledge about the postglacial paleoclimates of the Canadian Arctic to provide a context to understand the current global warming. Several types of proxy-climate data provide information about past conditions, including ice cores, peat deposits and lake sediments. Treeline variations have been reconstructed using pollen assemblages and indicate different climate sequences for the eastern, central and western portions of the Canadian North. In the Canadian Arctic, warm temperatures occurred in the early Holocene, with significant impacts on the tundra and polar desert ecosystems. The timing of climate transitions is not well constrained due to the difficulty in dating paleoclimate archives, but important transitions identified in other regions impacted Arctic environment, including transitions at 8.2 kyr BP, 4.2 kyr BP and the Little Ice Age. Higher-frequency variations, especially from the last 200 years, have been identified in some lake sediment records

4C4.5
Hydrology of Northern Quebec simulated by the Canadian Regional Climate Model.
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Results from an ensemble of 30-year simulations performed with the Canadian Regional Climate Model (CRCM) are used to analyze simulated hydrologic regimes over 21 basins located on the Quebec/Labrador peninsula. Catchment basins of interest cover areas ranging from 13 000 to 177 000 km^2, giving a combined drainage area of 1 000 000 km^2. The CRCM was run using different configurations: (a) it was driven either by NCEP/NCAR or ECMWF ERA40 6-hourly global atmospheric reanalyses, or by CGCM3 6-hourly atmospheric climate simulation outputs (b) it was run either on a large domain covering most of North America or on a smaller domain centered over Quebec and (c) it used either the multi-layer Canadian LAnd Surface Scheme (CLASS) or a simple one-layer scheme. All simulations were run with a 45-km horizontal grid-size mesh, 29 vertical levels and 15-minute time steps. Over the study basins, we compare annual

series obtained from the CRCM simulations with observed runoff and precipitation in recent climate. We also investigate the influence of: (1) domain characteristics, (2) surface scheme, and (3) driving data on surface hydrologic budget components. Finally, climate change projections from CRCM simulations will be examined with respect to hydrology.

2C2.7

A GIS application in extreme winds forecasting

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Mesoscale numerical models are essential for accurate forecasting of high impact weather. But, due to imperfect representation of the land-sea mask and surface topography in models, it is difficult to produce precise mapping of the model forecasts. Geographical Information System (GIS), with its capability for displaying, managing and modeling spatial data, has great potential for display of weather data for analysis and forecasting.

In this study, the 498 version of the Mesoscale Compressible Community (MC2) mesoscale model is used to produce 24 hr 4 km grid forecasts of an extreme-wind event that occurred over Southwest British Columbia on January 1, 2006. With RPN FST-GRIB encoder, National Weather Service (NWS) NDFD GRIB decoder and ESRI desktop ArcGIS 9.1 software, a set of GIS based digital extreme wind forecasts is produced from MC2 outcome. Preliminary results confirm that teaming digital weather forecast data with ESRI desktop GIS can provide powerful technical tools for forecasters and decision makers regarding high-impact weather warning. More details will be presented.

2B3.4

Impact of post-field data processing on CO2-flux estimates from eddy covariance measurements

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Eddy covariance measurements are widely used to determine the net ecosystem exchange of carbon dioxide. This study evaluates the impact of post-field data processing methods on eddy covariance flux estimates. To that end, a dataset from the LITFASS-2003 field campaign in the vicinity of the Meteorological Observatory Lindenberg of the German Weather Service was analysed using an experimental software package. Widely discussed issues in data processing, like an adequate flux averaging time, coordinate transformations, and alternative approaches for the correction of density effects are examined. The impact of all the single processing steps on CO_2-flux estimates is demonstrated. The mean value of the CO_2-flux can be halved or doubled through the correction for density effects. The approach after LIU (2005) leads to an increased net assimilation estimate by 26% compared to the classic WPL correction. Large flux contributions from wavelengths longer than 30 minutes were found for the CO_2-flux at the test site. Very longwave turbulent structures can be explained through the strong heterogeneity of the surrounding landscape. This thesis is also supported through an LES analysis.

3DPA2.11

Deriving Snowfall using measurements from Sonic Ranging Sensors

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Environment Canada is developing a multi-parameter algorithm to derive snowfall from snow on ground measurements. Field studies conducted at several locations across Canada over the winters of 2004-05 and 2005-06, produced data sets which included hourly/daily human weather observations. Readings from three Campbell Scientific Sonic Ranging Sensors (SR50), and a Geonor Total Precipitation Gauge, were filtered and combined to produce a "snowfall" statistic. A brief overview of the structure of the algorithm, case studies showing the influences of meteorological effects on the SR50 readings, and problems using Sonic Ranging Sensors will presented.

1B2.3

Linkages between the Hydrometeorology and Arctic Lab and the Prairie and Arctic Storm Prediction Centre: supporting the summer severe weather warning program

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The creation of National Science Labs within the Meteorological Service of Canada (MSC) has enhanced opportunities for collaboration between the science and operational forecasting communities. The Hydrometeorology and Arctic Lab (HAL) is co-located with the Prairie and Arctic Storm Prediction Centre (PASPC) in Edmonton, Alberta and Winnipeg, Manitoba. The primary foci of the HAL are in the areas of hydrometeorology and Arctic meteorology with efforts given to other regional needs as required. The national labs are tasked with facilitating knowledge and technology transfer to regional storm prediction centres and the HAL contributes directly to the PASPC forecast program in a number of ways including local mesoscale modelling, development of forecast tools and conceptual models, and participation in training initiatives and weather briefings. The current presentation focuses on three initiatives in support of the PASPC summer severe weather program.

In spring 2006 the HAL introduced the second edition of an operational reference manual and accompanying internal web site entitled, “Forecasting Summertime Convection”. This over 200 page manual provides a practical review of theory, conceptual models, and forecast techniques for the operational meteorologist during the warm convective season. Hardcopies of the manual were made available to all PASPC and Canadian Meteorological and Aviation Centre – West (CMAC-West) staff.

Leading up to the 2006 convective season, the HAL collaborated on the design of, and participated in, a convective weather Community of Practice (CoP) led by PASPC staff in Edmonton. The CoP consisted of four full-day sessions for all PASPC supervisors and severe weather meteorologists focusing on areas of convective theory and conceptual models, remote sensing, forecast techniques and situational awareness. Each session was comprised of pre-assigned reading, lectures and participant presentations of journal articles to stimulate operationally specific discussions. The sessions utilized videoconferencing between the Edmonton and Winnipeg centres and participants were examined on the course material.

Beginning in summer 2006 the HAL is introducing a Research Support Desk (RSD) into PASPC operations during active times for summer and winter high impact weather. This effort follows from work done at the Ontario Storm Prediction Centre (OSPC) led by Dave Sills from the Meteorological Research Branch (MRB) of Environment Canada. The RSD will provide real-time mesoscale analysis, forecasting and nowcasting details, and exposure to new tools and techniques to PASPC meteorologists. The RSD will also allow for identification of knowledge gaps and needs of the SPC that can be addressed by the national labs.

4DPA6.24

Development and Implementation of a New MSC Operational Air Quality Forecasting Modelling System (AQFM) to replace CHRONOS in 2007

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In the summer of 1999, the Meteorological Service of Canada (MSC) initiated the Air Quality Forecasting Prediction Program, using the Canadian Hemispheric and Regional Ozone NOx System (CHRONOS) to forecast ozone over North America. The meteorological driver used by this off-line chemical transport model is the regional operational version of the MSC Global Environmental Multi-scale model (GEM). In order to address the limitations of the current operational off-line version of CHRONOS and to meet new research and technical challenges in the future, Environment Canada has initiated a new project whose goal is to build a new *in-line* operational air quality forecast model inside GEM by 2007, with capabilities and performance at least equivalent to CHRONOS. This new AQFM will take advantage of GEM's ability to run on massively multi-parallel supercomputers. The new AQFM will go through several formal evaluations and a series of testing procedures at different stages of the development project.

1C1.3

First Canada-wide validation of a new global leaf area index product using SPOT-4 VEGETATION

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A new set of recently developed LAI algorithms is employed to produce a global LAI dataset at 1 km resolution in 10-day intervals from multiple years from 1998 to 2003, using SPOT-4 VEGETATION data. This dataset can be an important input into many large scale models for monitoring ecosystem productivity, and carbon, water and energy fluxes between the atmosphere and the land surface. We present the results of the initial validation of the new product using ground measurements at several sites across Canada. A Locally Adjusted Cubic-Spline Capping method is implemented to remove residual atmospheric effects based on the LAI seasonal trajectory of each pixel. Error analysis was implemented with a goal of assessing the role of individual bias sources - differences in land cover classifications and a quality of input sensor data were identified as the largest source of scene-wide bias errors; the aggregation of the images lead to a reduction of errors on the order of 20%. The remaining significant bias errors were found over mountainous areas where topographic shadowing, foliage clumping and bidirectional variation are problematic. Further research should concentrate on the removal of the topographic effects, and development and incorporation of datasets of global fields of the foliage clumping index and background reflectances. The same VEGETATION LAI product was also assessed against the Bigfoot sites in USA; the accuracy was comparable to or higher then the existing MODIS LAI product, suggesting that this new product could be a sound alternative to the global MODIS LAI product.

3DPA1.10

The impact of lateral boundary data errors on the simulated climate of a nested Regional Climate Model

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Important tools to study anticipated climate changes at regional scale are represented by high-resolution Regional Climate Models (RCMs) driven by the large-scale information from General

Circulation Models (GCMs). The GCM-simulated data contain errors due to model imperfections and therefore the RCM simulations are affected by these errors. In this study, we investigate the response of an RCM to errors in lateral boundary conditions (LBCs) using a perfect-model framework nicknamed the “Big-Brother Experiment”.

A large domain high-resolution RCM simulation, named Perfect Big Brother (PBB), serves as reference virtual-reality climate. Errors of adjustable magnitude are introduced by performing RCM simulations, named Imperfect Big Brother (IBB), with increasingly larger domains at lower resolution. The IBB data are used, after removing small scales at the typical resolution of today’s GCM, as LBCs for smaller domain high-resolution RCM runs, called Little Brother (LB). The climate statistics of IBB are compared to those of PBB in order to estimate the errors of nesting model, and LB climate statistics to those of PBB to estimate the errors resulting from nesting with imperfect LBC.

The simulations are performed over the East Coast of North America for five consecutive February months, using the Canadian RCM. The results indicate that the LB reproduces the IBB large-scale errors. The small scales improve slightly in regions with important orographic forcing, but generally, the LB restores a great part of the driving-model small-scale errors. Therefore, it is necessary to provide accurate large-scale circulation at RCM lateral boundaries to obtain correct small scales.

1DPA1.1

The new CMC medium-range Perfect-Prog temperature forecast system

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A new statistical post-processing system for spot temperatures has been developed for the medium-range forecast needs of the Canadian Meteorological Centre. The statistical approach of this new system is based on a Perfect-Prog methodology. The rational for developing this new Perfect-Prog system was driven by the need of a model-independent statistical post-processing technique to be applied on ensemble model outputs. In effect, the maintenance of a model-dependent post-processing system such as MOS for a large number of models having various model errors is prohibitive.

In the development stage, statistical regression equations are constructed by regressing NCEP reanalysis (the predictors) on the 2m-temperature observations (the predictand). This database provides a long (40 years) and stable time series of atmospheric analyses, which are necessary for building reliable regression equations. In real-time forecast mode, the statistical equations are applied using predictors extracted from NWP model output forecast fields. Compatibility of model resolution with the NCEP reanalysis database is achieved by spectrally filtering the NWP output with spherical harmonics.

The new Perfect-Prog system produces temperature forecasts twice a day at 900 locations across Canada and with a projection time of 5 to 16 days depending on the application. This new system has been tested on the CMC ensemble medium-range forecast system as well as on the CMC global high-resolution medium-range NWP model (GEM) output. The superiority of the new

system over the direct NWP model output will be shown. Comparisons against the old Perfect-Prog and the Updatable UMOS will also be exposed.

1DPA1.12
Forecasting Lightning Beyond Nowcasting: Updated Models
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Statistical models to forecast lightning probability in three-hour intervals to 48 hours have run at the Canadian Meteorological Center April – October since 2003 (Burrows et al., 2005). The forecasts demonstrate good skill overall and are widely used. Since the current models were developed it has become possible to include new predictors and extend forecast coverage to areas not presently included such as northern Canada.

There are two are predictands in the new models: (1) "chances" of lightning, and (2) expected number of flashes per three-hours. Several predictors from GEM's Kain-Fritsch convective parameterization are included plus important environment predictors identified in the current models. Predictands and predictor calculations are on a moveable 9*9 grid centered on each grid point at each time in each three-hour diurnal period (t-3, t-2, t-1, and t hours). Derived predictors are expressed as statistics for the 324 points, e.g. the minimum Showalter index; fraction of points with maximum upward convection velocity greater than 20 m/s; mean convective rain rate where convection is activated. Data reduction keeps the number of predictors to less than 40. Tree-structured regression is used to build models for three-hour diurnal periods and predictand (16 models). Cross-validation shows the trees fit 80-90% of expected predictand variance. Trees have 300-700 nodes, giving quasi-continuous predictions. Training data consists of 1 day per month March to September 2005 for the entire lightning detection domain available in Canada, making periodic updating easier.

Tests with independent data show the new models perform well even in cold months, and should result in improved forecasts.

3DPA3.6
A Daily Lightning Flash Density Decision Tree Based on Upper Air Sounding Parameters
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Lightning activity associated with convective storms can be a useful indicator of storm severity. Current models provide the probability of lightning occurrence and intensity based on GEM modeled data[1]. The decision trees herein described have the advantage of being derived from indices calculated from actual sounding data and can be used to provide average lightning densities for days with comparable predictor values. This in turn has the potential to help determine the potential storm severity for a region on any given day. These decision trees also hold the potential to be applied in studies regarding the relationship between daily lightning total and convective precipitation[2].

Using tree-structured regression[3], we construct decision trees based on 12 UTC upper air sounding parameters and lightning observations from the Canadian Lightning Detection Network. Lightning and sounding data from Canada and the northern United States from 1999-2005 are used to construct and cross-validate the tree structure. The predictand is the daily lightning flash count per unit area within a 100km radius of the sounding station where a day is defined to be from 12 UTC to 12 UTC. It was found that a range of flash densities can have similar predictor values therefore flash densities are linearized to minimize variance[1]. Though many possible

predictors were tested, preliminary results show that the Showalter Index and the 700mb-500mb lapse rate are among the highest rated indices.

[1] Burrows et al., 2005: *Warm Season Lightning Probability Prediction for Canada and the Northern United States*, WAF, 20, 971-988.
[2] Kochtubajda et al., 2005: *Convective Precipitation and Cloud-to-Ground Lightning Relationships in Canada, AMS Conference on Met. App. of Lightning Data*, Jan 9-13, 2005, San Diego, CA.
[3] Venables, W.N. and B.D. Ripley, 2002: *Modern Applied Statistics with S*, 4th ed. Spriner-Verlag, 495 pp.

4DPA8.4
Surficial and submarine freshwater discharges in a tidal Mediterranean embayment: hydrology and seawater optical characteristics
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Freshwater, groundwater and coastal seawater interactions have received considerable attention during the past decade, due to increasing interest regarding basin-scale inputs into the coastal zone. Here we present information regarding the influence of freshwater inputs from coastal springs and submarine freshwater discharges SGD on: (1) temperature, salinity, chlorophyll-a, and particulate matter, and (2) optical seawater characteristics.

The study area is situated at the northern sector of south Evvoikos Gulf, in central Greece (eastern Mediterranean Sea). Field measurements revealed that the inflow of surficial and submarine freshwater (brackish, salinity 6-7 psu) discharges affected substantially the horizontal distribution of the parameters measured in terms of: (1) lower temperature (min 14.7 °C); (2) lower salinity (min 28.3 psu); (3) higher PMC (max 8.5 mg l^{-1}); and (4) higher chlorophyll-a concentration (max 3 $\mu g\ l^{-1}$). Freshwater flowing along the coast from small sub-aerial springs was distributed over the area as a thin surficial film (~1 cm), with decreasing trend as the distance from the sources increased. By contrast, SGD appeared as permanent gyres of a 3-5 m diameter. Processing of radiometer data revealed the most appropriate wavelengths for the spectral detection of the SGD (488.20-573.33 and 552.85-769.70 nm for radiance and reflectance, respectively).

The evaluation of groundwater pathways and fluxes into the coastal zone can be made with the use of natural tracers as ^{222}Rn. A test measurement has been performed with a submarine gamma-ray detector (K-A-TE-RINA) and revealed high ^{222}Rn concentrations in SGD.

3C2.7
An enhanced PNA-like climate response to Pacific interannual and decadal variability
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The observational record and a 1000-year climate modelling analysis suggest a PNA-like climate response when Tropical Pacific interannual (ENSO) variability is in phase with Northern Pacific decadal-interdecadal (PDO) variability. Atmospheric heating anomalies of the same sign appear in both the Tropical Pacific and the North Pacific in association with this variability. Both sources of variability provide energy transports towards North America and thus give rise to stationary wave anomalies.

1DPA3.4
Visibility in Arctic blowing snow: measurement and modelling
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A study on visibility during Arctic blowing snow events was conducted in Franklin Bay, NWT, Canada from mid January to early May 2004 during the CASES 2003-2004 expedition. Visibilities at two heights, wind profiles, temperature profiles, and snow particle densities at different heights were monitored continually during the period. Based on these field data, the relationships between visibility, wind speed and particle counts were investigated. The particle counter readings had a good relationship with visibility and could be a good indicator of visibility. While there is a good empirical relationship between visibility and wind speed in each of the individual blowing snow cases, a single unique empirical relation would contain significant scatter when attempting to apply one relation to all blowing snow events. This indicates that the relationship between wind speed and visibility may be influenced by ground snow conditions. The PIEKTUK blowing snow model was run to simulate visibilities in blowing snow. We will discuss the results and limitations.

1DPA2.5
Temperature dependent indices of refraction of ammonium sulfate
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Remote sensing of aerosols in the troposphere and stratosphere by optical means requires a knowledge of the complex refractive indices of the target materials in a temperature range from about 200 K to 300 K. Ammonium sulfate is a very common condensed phase constituent of the continental troposphere and its quantification is important to the understanding of many atmospheric processes. We have determined the complex refractive indices for crystalline ammonium sulfate at 4 cm^{-1} intervals between 500 and 6000 cm^{-1} from IR extinction spectra of ammonium sulfate aerosols measured in an aerosol flow tube (AFT) at a pressure of 1 bar and for temperatures of 213, 223, 243, and 298 K. The extinction spectra are inverted to produce indices of refraction using a recently-reported numerical procedure. We find only minor variations in the indices of refraction between 223 and 298 K, but at temperatures below 223 K, ammonium sulfate undergoes a ferroelectric transition with a consequent change in the optical properties. The measurements, inversions and resulting indices of refraction will be reported in this presentation.

1C3.2
Angular Momentum Conservation and Gravity Wave Drag Parameterization: Implications for Climate Models
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We examine the robustness of the parameterized gravity wave response to an imposed radiative perturbation in the middle atmosphere. When momentum is conserved and for reasonable gravity wave drag parameters, the response to a polar cooling induces polar downwelling above the region of the imposed cooling, with consequent adiabatic warming. This response is robust to changes in the gravity wave source spectrum, background flow, gravity wave breaking criterion, and model lid height. When momentum is not conserved, either in the formulation or in the implementation of the gravity wave drag parameterization, the response becomes sensitive to the

above mentioned factors --- in particular to the model lid height. The spurious response resulting from non conservation is found to be non-negligible in terms of the total gravity wave drag induced downwelling.

3DPA1.7
Influence of Domain Size on the Geographical Distribution of RCM Internal Variability
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Regional Climate Models (RCMs) are commonly used to overcome Global Climate Model's (GCM) poor resolution by adding fine-scale details upon the GCM large-scale flow. Due to nonlinearities in the model physics and dynamics, RCMs can produce different time evolutions of simulated fields, if a small perturbation affects the initial conditions (IC). This sensitivity, usually called internal variability, is partially controlled by the lateral boundary forcing, and hence size and geographical location of the integration domain play an important role. Internal variability of RCMs is in general smaller than that of GCMs. It is important to evaluate the internal variability of the RCMs, because it can mask physically forced signals and hence affect the assessment of climate sensitivity to forcings.

A large ensemble of twenty three-months simulations differing only in initial conditions, over a set of different domain sizes, was generated with the Canadian Regional Climate Model (CRCM) to study internal variability of the model and its possible consequences for climate analysis. The results show that the internal variability, estimated as standard deviation between 20 ensemble simulations during summer season, depends strongly on synoptic events. We show that in convective areas (e.g., south of the US), large quantities of precipitation induce important differences between the simulations. The experience shows that a reduction of the domain size minimizes the freedom of the CRCM and, as a consequence, the internal variability of the model, including in convective areas, usually, areas of high internal variability. The study shows, in addition that, modifications of domain size imply a considerable variation in the geographical distribution of the internal variability.

4DPA6.15
Measurements of the HONO Photodissociation Constant
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(Presented by / Présenté par ***Kristin Wall***)
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Measurements of the photodissociation constant for nitrous acid (j_{HONO}) were made at an urban site in Toronto, Canada, during the months of May – July 2005, using an optically thin actinometer. The highly sensitive technique based on aqueous scrubbing of nitrous acid in a neutral buffer, followed by derivatization of nitrite to a highly light-absorbing azo dye with sulfanilamide (SA) and (1-naphthyl)-ethylenediamine (NED) in acidic solution (Huang et al., 2002) was used for the measurement of gas-phase HONO. Operating details of the j_{HONO} monitor are reported, along with laboratory tests. Measurements of j_{HONO} were obtained for solar zenith angles ranging from 20 - 85°, under clear and cloudy skies. Measured clear-sky values of j_{HONO} were compared with radiative transfer model values and were found to be in good agreement for SZA ≤ 60°. The enhancement and suppression of the HONO photodissociation constant due to the presence of clouds was investigated. The use of modeled actinic fluxes along with experimental j values under clear sky conditions allowed for assessment of the absorption cross section, and the photodissociation quantum yield for HONO.

Huang, G., Zhou, X., Deng, G., Huangcheng, Q., Civerolo, K., 2002: Measurements of atmospheric nitrous acid and nitric acid, *Atmos. Environ*. 36, 2225 – 2235.

3C4.6

Evolution and global impacts of a diabatically-generated warm pool: Hurricane Katrina (2005)

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The landfall of Hurricane Katrina (2005) near New Orleans, Louisiana on 29 August 2005 will be remembered as one of the worst natural disasters in the history of the United States. By comparison, the extratropical transition (ET) of the system as it accelerates poleward over the following days is innocuous and the system continually weakens until its eventual demise off the coast of Greenland. The extent of Katrina's perturbation of the midlatitude flow would appear to be limited given the lack of reintensification or downstream development during ET; however, the slow progression of a strong upper-tropospheric warm pool across the North Atlantic ocean in the week following Katrina's landfall prompts the question of whether even a non-reintensifying ET event can lead to significant modification of the midlatitude flow. Analysis of Hurricane Katrina's outflow layer after landfall suggests that it does not comprise the long-lived midlatitude warm pool. Instead, it curls anticyclonically and re-entering the tropical warm source region east of Florida. However, the interaction between Katrina's anticyclonic outflow and an approaching baroclinic trough is shown to establish an anomalous southwesterly conduit that injects a pre-existing warm pool over the southwestern United States into the midlatitudes. This warm pool reduces predictability in medium-range forecasts over the North Atlantic and Europe while simultaneously aiding in the development of Hurricanes Maria and Nate. The origin of the warm pool is shown to be the combination of anticyclonic upper-level features generated by Eastern Pacific Hurricane Hilary and the South Asian Anticyclone. The global nature of the connections involved with the development of the warm pool and its injection into the extratropics has an impact on forecasting since the predictability issue associated with ET in this case involves far more than the potential reintensification of the transitioning system itself.

1B4.7

Influence of the Hudson Bay sea-ice on regional climate

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The Canadian Regional Climate Model (CRCM) has been coupled with a regional ice-ocean model in the Hudson Bay. A four-year simulation (control run) has been performed using NCEP reanalyses as lateral boundary forcing. The coupled model demonstrates ability to adequately reproduce the annual cycle of the Hudson Bay sea-ice cover. The influence of sea-ice on regional climate during the sea-ice freeze-up period has been investigated by performing three test runs in which the formation of the Hudson Bay sea-ice is delayed by two weeks. The simulation results from both control run and test runs are evaluated using Hudson Bay sea-ice observations, the meteorological and hydrological observations available in La Grande basin of Quebec. Observations show that the sea-ice area over the Hudson Bay is strongly correlated with the temperature and precipitation anomalies in La Grande basin during the sea-ice freeze-up period and seems to suggest that the Hudson Bay sea-ice be responsible to the temperature and precipitation variability. However, the simulation results show that the influence of sea-ice on temperature and precipitation in La Grande basin is small (compared with the observed

variability) and suggest that the sea-ice cover over the Hudson Bay is not responsible to the variability. It is shown that the North Atlantic Oscillation (NAO) is the major factor that influences both the sea-ice cover over the Hudson Bay and the regional climate in La Grande basin.

3C4.4 **INVITED / INVITÉ**

A New High-Resolution Medium-Range Weather Forecast Model at the Meteorological Service of Canada

Stéphane Bélair , Michel Roch , Anne-Marie Leduc , Stéphane Laroche , Paul Vaillancourt
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A new high-resolution atmospheric model is on the verge of being implemented at the Meteorological Service of Canada (MSC) for operational medium-range weather forecasts. In addition to the significant increase in horizontal and vertical resolution (33 km versus 100 km and 58 levels versus 28 levels), many of the physical processes represented in the model have been improved. The Kain-Fritsch scheme is now used for deep convection, together with a newly-developed shallow convective scheme, called Kuo Transient. Also, the Bougeault-Lacarrère mixing length is now uded in the turbulent diffusion scheme. And the ISBA land surface scheme has been implemented, with initial conditions for soil moisture provided by a land surface sequential assimilation of low-level air characteristics. Intensive testing of this new system show significant improvement of the comparison against radiosondes and upper-air analyses (RMSs, biases, anomaly corelations), especially over the medium-range portion of the integrations (i.e., after 3 days of integration). As well, verification against surface stations, global precipitation analyses, and remote-sensing observations indicate a much better representation of condensation processes in the new system. In particular, it is found that the new system is able to better capture intense precipitation events, as well as soil hydrology anomalies. These positive results will be presented at the conference, along with discussions on the strengths and weaknesses of the new configuration, and prospects of future modeling developments.

1C4.8

Discontinuities in climate datasets: a challenge for studying climate change in the Arctic

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The National Climate Data Archive from Environment Canada contains official weather and climate observations for the country. Surface temperature, precipitation and humidity observations are available from the archive for studying climate change in the Arctic. However, caution should be used for the interpretation of climate trends since sometimes artificial discontinuities were created due to site relocation or changes in instruments and observing practices. Rigorous examination of climate datasets and adjustment for data problems are essential for the proper detection and understanding of climate change. A statistical technique based on regression models was used to identify and adjust discontinuities in climate data and the cause of the discontinuity was retrieved from the station history files when possible. The objective of the presentation is to provide some examples of discontinuities in climate datasets at some locations in the Canadian Arctic and a general assessment of the annual and seasonal trends for the past 50 years.

2DPA6.8

Diagnostics on the 2002 Sudden Warmings in the Southern Hemisphere

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CMAM-DA analyses are used to examine the warming events in September 2002 with the focus on the change of temperature and wind structures in the upper stratosphere and mesosphere.

The major warming is identified by examining the the time series of temperature at 88.14S, and time series of zonal mean zonal wind at 60S on 10mb in September 2002. PV maps on 10mb in the last five days in September show more detailed structure of split vortex. Three minor warmings (occurring on Aug 25, Sept 2, 18) are also identified from CMAM-DAs analyses. The change of temperature and zonal wind in the SH mesosphere during the warming events is investigated using the time-height cross sections of temperature at 88.14S and of zonal mean zonal wind at 60S. The cross sections show that (1) corresponding to stratospheric minor warmings there are three mesospheric warmings but with a larger temperature increase; (2) there is a short time zonal mean wind reversal near the mesopause during the minor warming periods; (3) the mesosphere near the south pole has a strong cooling during the stratospheric major warming period but also has the reversal of zonal wind at 60S. CMAM-DAs analyses show that the temperature difference between 88.14S and 60S on 10mb is very small and negative at the peak of the minor warming. It becomes positive when major warming starts. Near the mesopause, however, the temperature difference is very small but positive during the minor warming periods and becomes negative when major warming starts.

1DPA2.3
Extracting features of lake ice phenology over Canada from daily AVHRR observations
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Changes in climate are expected to have profound affects on Canadian freshwater fisheries. However, studies of climate change impact on fisheries are hindered by the lack of data for analyzing the large spatial scale dynamics of lake water and ice regimes and their relationship with climate. Here, we demonstrate the utility of daily AVHRR 1km satellite data for extracting important features of lake ice phenology. These features correspond to (a) the earliest and latest dates of complete ice cover for lakes that freeze completely in the winter, (b) the earliest and latest dates of complete water cover for lakes that thaw completely in the summer, and (c) the dates of maximum (minimum) ice cover for lakes that do not freeze (thaw) completely in the winter (summer). Our study focuses on the lake ice phenologies of over 500 large Canadian lakes (> 100 Km^2) during the period 2001-2003. We also estimated the daily ice fraction of each lake during the thaw/freeze period on days that observations were available. Because few data to validate our approach exists for 2001-2003, we validated our approach using AVHRR data and in situ Canadian Ice Database observations for various years in the 1990s. Our validation shows a good agreement between ice phenology features extracted from the AVHRR data with ground observations, suggesting that the features estimated for 2001-2003 are similarly accurate. We are presently analyzing the relationship of these trends and their relationship to climate.

1C1.5
Preliminary Results from the Fog Remote Sensing and Modeling (FRAM) Field Project
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Preliminary results will be summarized using observations collected during the Fog Remote Sensing and Modeling (FRAM) field project. The FRAM project is designed to study fog formation and development. The current focus is on two geographical areas and time frames: 1) Ontario during the Nov. 2005-May 2006 time period and 2) Nova Scotia during the summer of 2006. Both warm and ice fog phenomena are being investigated. The measurements at each field site will include liquid water content (LWC), droplet number concentration (N_d) and size, aerosol concentration (N_a), visibility, LWC profiles and liquid water path (LWP), cloud base height, precipitation amount and type, and other conventional weather-related measurements, including relative humidity (RH), temperature (T), and wind. In addition to these measurements, remote sensing observations from the McGill X-band vertical pointing cloud radar, and satellites, including MODIS and GOES are used in the analysis. Preliminary results from the Ontario

(mainly wintertime) field study suggest that 1) warm rain precipitating over snow surfaces was the main reason for fog formation in Southern Ontario, 2) N_d, in addition to LWC, should also be included in the parameterization of visibility, 3) airmasses in Ontario that moved from the SW-S direction likely increased fog formation with low visibilities, and 4) the maximum diameter of fog droplet size was about 15-20 micrometers. Overall, the results will be summarized and discussed related to satellite observations and model applications.

1DPA1.19
Validation of Surface Precipitation from Volumetric Doppler Radar Data Using the WATFLOOD Hydrological Model
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As part of the Enhanced Nowcasting of Extreme Weather project, the University of Waterloo Hydrology Lab currently receives four different radar precipitation products from McGill University's J.S. Marshall Radar Observatory. Our goal is to evaluate the impact of meteorological modeling skill on our ability for water resources management.

Each radar product is used as precipitation input to the WATFLOOD Hydrological model. Streamflow hydrographs for various gauging stations within the radar domain are produced and compared to observed values and modeled results using distributed rain gauge data from the Montreal Mesonet. It was previously determined that where overlapping coverage of radar and rain gauge network exists, the C3 radar product with corrections based on the Vertical Profile of Reflectivity (VPR) produces streamflow hydrographs that best match those derived from gauge rainfall alone.

Recent improvements to the WATFLOOD model and the addition of field data have allowed us to reduce model uncertainty and further understand anomalies within the radar-derived hydrographs. It will be shown that although scatter plots often show good correlation between radar and rain gauge measurements, temporal and spatial variations in the Z-R relationship still prevent us from consistently forecasting flows in small watersheds within an acceptable error level. For larger watersheds, however, errors in time and space are cancelled out. In order to make radar useful for flow prediction in both small and large watersheds further improvements in weather radar processing are needed. These improvements will probably require methods to vary the Z-R relationship in time and space.

3A1.2 **INVITED / INVITÉ**
A Unified Approach to Weather, Climate, and Earth-System Prediction for the 21st Century
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Advances in monitoring and predicting short-term weather hazards, climate variability and climate change, and the means to provide this information to socioeconomic sectors and environmental policy makers represents one of the most significant scientific, technological and societal achievements of the 20th century. Yet despite the notable increase in predictive skill over a broad range of time scales, there remains a necessity for further improvements to achieve a higher level of societal benefit. It can be said that the advent of Numerical Weather Prediction (NWP) lead to a major breakthrough in environmental prediction by transforming weather forecasting and climate prediction from an empirically-based science into one founded upon the laws of physics and their application through advanced mathematical techniques and high-speed computers. Global societies currently reap substantial benefits from weather and climate predictions and their

inherent uncertainties. These benefits include: i) reduced vulnerability to natural weather hazards; ii) weather, climate and complex Earth-system predictions for societal, economic, and environmentally sensitive sectors, e.g., agriculture; health; energy; water-resource management; air quality; transportation; leisure industries; ecosystems; bio-diversity; iii) quantitative assessment of the probability of occurrence and severity of a given outcome. It should be recognised that weather and climate conditions with high socioeconomic and environmental impact may be infrequent, but the consequences of occurrence can be catastrophic to those societies and Earth systems that are affected. This position paper presents an overview of recent advances in weather, climate and complex Earth-system prediction and the opportunities for further advancements. It describes the computational and human resource requirements necessary to enable these advances and the deliverables and the extraordinary benefits to be derived from collaborative research across weather, climate, Earth-system and socioeconomic application communities. It aspires to provide a framework for an International Weather, Climate, and Earth-system Science Initiative to enable quantum advances in knowledge and prediction of weather, climate and the Earth system; a multi-national, multi-disciplinary endeavour comparable in scope to the International Space Station, Hubble Telescope, CERN and Fusion Research projects.

4B2.1
Gabriel T. Csanady: Understanding the Physics of the Ocean
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Gabriel Csanady has been a key referent in Oceanography for over forty years. During this period he has published some 200 papers and four monographs, making substantial contributions to almost all possible fields in Physical Oceanography. Gabe arrived to Canada in 1961, where he stayed until 1972 (University of Windsor, University of Waterloo, and associated to the University of Toronto), and worked on the circulation and diffusion in the Great Lakes. During this period he wrote his first (Theory of Turbomachines, 1964) and second monographs (Turbulent Diffusion in the Environment, 1973), and did major research that eventually lead to his third monograph (Circulation in the Coastal Ocean, 1982). In 1973 Gabe moved to the United States, Woods Hole Oceanographic Institution (1973 to 1987) and Old Dominion University (1987 to 1995). In his recently published fourth monograph (Air-Sea Interaction: Laws and Mechanisms, 2001) Gabe shows his deep physical insight and global approach to Oceanography, merging knowledge and creativity to face problems ranging from small-scale air-sea interaction to large-scale ocean-atmosphere dynamics. The 40th CMOS Congress, 45 years after Gabe's arrival to Canada, is a wonderful opportunity for us to make a public tribute to Gabriel Csanady for his humanity and his artistry in the fields of Limnology and Oceanography, from inland waters to the coastal and deep oceans.

1DPA1.20
Large Current Lightning Flashes in Canada
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This study examines the characteristics of large current cloud-to-ground lightning flashes (LCLF) recorded by the Canadian Lightning Detection Network (CLDN) across Canada's eco-climatic regimes. We have defined LCLFs as flashes with peak currents > ±100 kA. Six years (1999-

2004) of CLDN data were examined. Analysis of nearly 15 million cloud-to-ground flashes over this 6-year period indicates that LCLFs are rare occurrences, comprising approximately 0.5% of the annual cloud-to-ground flashes detected in Canada. About 52% of the LCLFs are positive CG flashes. Large current flashes are detected throughout the year, but distinct seasonal and geographic differences in their distributions are observed.

The majority of LCLFs in the winter months is detected along the Pacific coast of the cordilleran zone and temperate zone of eastern Canada. The greater part of annual LCLFs occurs during the summer. Some flashes have been detected as far north as Southampton Island in northern Hudson Bay. The southward passage of the Arctic front in early fall diminishes LCLF occurrence over the arctic and boreal zones. Analyses of the diurnal distributions reveal two peaks of activity occurring in the early mornings (9-12 UTC) and late afternoons (20-01 UTC) during all seasons except winter. Analyses of the average stroke multiplicity also reveal seasonal and geographic differences. Most of the LCLFs with multiplicity ≥ 10 are associated with negative CG flashes and detected in all seasons except winter over several areas of the country. Positive flashes with multiplicity ≥ 10 have only been detected in the summer over the boreal zone of central Alberta and Saskatchewan.

2C2.4
Numerical Modeling of Atlantic Hurricanes
Moving into the Middle Latitudes

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NUMERICAL MODELING OF ATLANTIC HURRICANES
MOVING INTO THE MIDDLE LATITUDES

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ABSTRACT

Hurricanes that form over the Atlantic Ocean very frequently migrate into the middle latitudes where they encounter much different oceanic and atmospheric conditions than in the tropics. Cool sea surface temperatures (SSTs) cause these storms to weaken and become thermodynamically decoupled from the ocean, while baroclinic atmospheric environments often cause them to reintensify into extratropical storms ─ a process known as extratropical transition (ET). The changing structure of these storms in the middle latitudes presents many unique forecasting challenges related to the increasing asymmetry in moisture and wind fields.

An examination of three such events over Eastern Canada ─ using a combination of observations and a numerical model ─ forms the foundation of this work, with an emphasis on applying the research to weather forecast applications. The case studies include Hurricane Michael (2000), Hurricane Karen (2001) and Hurricane Juan (2003). Hurricane Michael intensified in a strongly baroclinc environment and evolved into an intense extratropical storm over Newfoundland. Karen also underwent ET, but weakened quickly while approaching Nova Scotia, while Hurricane Juan struck Nova Scotia as a category-two hurricane, experiencing only marginal weakening over anomalously warm SSTs. In essence, these cases represent a cross section of the behavior of many tropical cyclones in this part of the world.

Hindcast simulations are conducted for each event using the Canadian Mesoscale Compressible

Community (MC2) model with a synthetic, observationally-consistent hurricane vortex used in the model's initial conditions. Sensitivity experiments are run for each case by modifying initial specifications of the vortex, model physics parameterizations, and surface boundary conditions like SST. For Hurricane Juan, it was determined that the anomalously-warm SSTs played a significant role in the landfall intensity. The model is also run in "forecast mode" to test its suitability as a prognostic tool for meteorologists. Significant improvements in the representation of the moisture and mass fields is observed in all three cases compared with numerical forecast models that did not employ vortex insertion in the initial atmospheric fields.

4B1.5
Heterogeneous chemistry of organic particles and aqueous particles coated with organic films
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Field measurements have shown that organic material is abundant in the atmosphere, comprising 10-70% of the total fine particulate mass. Organic particles can be oxidized in the atmosphere by radicals such as OH and NO_3. This could change the hygroscopicity of the particles and possibly lead to volatilization.[Molina et al. GRL 2004] To better understand this chemistry, we have investigated the oxidation of organic substrates by NO_3 radicals. The experiments were conducted using a flow tube reactor for kinetic studies and X-ray photoelectron spectroscopy for surface analysis. The results show that NO_3 radicals can rapidly process organic surfaces in the atmosphere: the time for oxidation of an alkane surface by NO_3 is on the order of one day for tropospheric conditions. The results also show that NO_3-initiated oxidation does not lead to rapid volatilization. This is in contrast to OH radicals, which initiate volatilization of organic surfaces based on previous measurements.[Molina et al., GRL, 2004]

Surface-active organic molecules (organic molecules that have both a hydrophobic group and a hydrophilic group) are common constituents of tropospheric aerosol particles. Several researchers have suggested that these organic molecules form organic coatings or films on the surface of aqueous particles in the troposphere.

Using a newly constructed flow cell, we have investigated the effect of organic films on the hydrolysis of N_2O_5 on aqueous surfaces. The results show that single component organic monolayers, such as octadecanol monolayers, can decrease the reactive uptake coefficient of N_2O_5 on aqueous surfaces by approximately a factor of 50.

4B2.8
Mass and vorticity transfer into boundary currents over the continental slope
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We examine the vorticity balance in a stratified boundary flow over the continental slope. For this purpose we use the non-divergent form of the steady-state potential vorticity equation, applied to an epipycnal control volume from the sea bottom into the boundary current. The behavior of the boundary current depends on how this balance is controlled by the mass and vorticity exchange with the bottom mixed layer and the interior ocean. The exchange at the ocean interior end usually depends on large-scale forcing, while at the top of the bottom mixed layer it is sustained through turbulence induced by the boundary current. The analysis gives an approximate equation for the cross-slope epipycnal velocity which, in conjunction with the mass conservation equation for zero epipycnal divergence, determines the along-slope evolution of the boundary current. We present the solution for scales corresponding to a western boundary current flowing along the continental slope, with water inflow from the interior ocean depending on wind forcing over the

whole ocean gyre, as proposed by Gabriel Csanady in his 1989 paper on western boundary upwelling. The solution reproduces the shape of the boundary current, which remains constant with the along-slope coordinate while its width increases. It also emphasizes the key role of the bottom mixed layer to sustain a mean non-zero downslope bottom flux, a likely important contribution to the heat transfer from the surface layers to the interior ocean.

3B3.6

Mean, Variance and Skewness of North Atlantic Sea Surface Temperatures Observed by Satellite Remote Sensing

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The spatial and temporal variations of sea surface temperature (SST) in the North Atlantic are derived from analyses of five-year satellite remote sensing data. The data are 8-day composites with 4 km spatial resolution, obtained from measurements by the MODIS instruments aboard the NASA Terra satellite. A least-squares fitting is applied to determine the annual mean and seasonal cycle, and both quantities agree well with those derived from a high-resolution climatology of temperature based on long-term hydrographic observations. The non-seasonal variations of SST are quantified by the standard deviation and skewness estimated from the remote sensing data. Strong non-seasonal variations are found in areas where the following processes occur: boundary current meandering, frontal instability, meso-scale eddy formation, and up-welling. The non-seasonal variations of SST are compared with those of the sea surface height (SSH) derived from satellite altimeter measurements. The SST and SSH measurements provide complementary information about the variability of the ocean and both should be used to examine the realism of high-resolution models and also identify physical processes operating in regions of interest.

3DPA3.13

Initial Soil Moisture as a Predictor of Subsequent Summer Severe Weather in the Cropped Grassland of the Canadian Prairie Provinces

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Soil moisture in the cropped grassland of the Canadian Prairies was obtained in early April, June 15 and July 15 for years 1997-2003 using a phenology and water use model for spring wheat. Dry areas (crop available moisture <50% of capacity), and wet areas (crop available moisture >50% capacity) were delineated each year. The relative number-of-occurrence for each event (tornadoes, hail, heavy rains, strong winds and all events) and the event days that occurred each year in the dry and in the wet areas during the remainder of the growing season subsequent to early April, to June 15 and to July 15 are correlated with the mean soil moisture in these areas. The goal is to investigate whether knowledge of soil moisture at various crop growing stages can be used as a “seasonal” predictor of severe weather. Stronger correlations exist between April and June initial soil moisture and the subsequent occurrences of events and days. It follows that the relative number-of-occurrences for each event and event days on the Prairies, subsequent to early April and June 15, is determined, in part, by the initial soil moisture. This suggests that areas that are initially wet, supply the atmospheric boundary layer with moisture and CAPE during subsequent months, a necessary but not sufficient condition for deep severe convection, while the supply of water vapour mass and latent heat is lower in the areas that are initially dry.

1DPA2.16

Ice Crystal Habit and Scattering Properties for Model Cirrus Clouds

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The light scattering properties of cirrus clouds depend not only on the ice particle size distribution, but also on the particle shape (habit), which therefore influences the Earth's radiative balance, and in turn, its climate. More than a decade ago, we developed a cryogenic aerosol flow tube to investigate the chemical and physical properties of model atmospheric aerosols and we have recently begun to use this in the study of cirrus cloud particles. The apparatus consists of a temperature-programmable flow section capable of operating down to 150 K, which is optically coupled to a Fourier transform infrared spectrometer used to record the IR spectra of aerosols in the flow section. To study crystal habit, we have recently added to this apparatus an optical microscope coupled to a CCD camera. This enables us to obtain images of the particles that complement the IR spectral measurements. In addition, we have developed a capability to interpret these images using ray-tracing techniques within the framework of geometrical optics. We have found that ice crystal habit depends strongly upon the cooling rate and mass-transfer processes in the flow tube and depending on these conditions, many complex and unexpected particle morphologies are produced. We will report measurements on water droplets and ice crystals in the size range from about 5 to15 micrometers that were carried out in the temperature range from -5 °C to -50 °C. We have measured the scattering intensity patterns for these particles using forward and 90-degree scattering geometries and have observed a wide variety of ice crystal habits. We will discuss the conditions under which the various crystal shapes and sizes are formed and provide a theoretical interpretation of the observed scattering patterns.

4DPA6.3

Analysis and Identification of Products formed during HO∙ Initiated Photo-oxidation of Environmentally Relevant Hydrocarbons

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The hydroxyl radical initiated oxidation of hydrocarbons in the atmosphere produces a diverse range of organic products, which depending on their vapour pressures, may be found in the gas, and/or particle phase. The identities of these secondary organic products, especially those in the particle phase, are not well known. We are using a smog chamber to perform atmospherically important oxidation reactions under controlled conditions with the objective of improving our knowledge of the chemical composition of the reaction products. The chamber is an $8m^3$ Teflon bag surrounded by an outer shell composed of two mobile sides lined with mylar and 24 black lights. Hydroxyl radicals are produced by photolyzing isopropyl nitrite in the presence of NO, and reactions can be performed with or without pre-existing particles. So far studies on the reactions of toluene and β-pinene have been undertaken. The concentrations of the hydrocarbon and NO_x are followed using a gas chromatograph (GC-FID) and a chemiluminescence analyzer respectively. A tandem differential mobility analyzer (DMA) and condensation nucleus counter (CNC) are used to determine particulate size distributions, from which particle yields are obtained. Identification of gas and particulate phase products is carried out using a Sciex TAGA 6000E triple quadrupole mass spectrometer with an atmospheric pressure chemical ionization source (APCI). The mass range, m/z 10-800, available for a single MS scan allows monitoring of products with larger and smaller masses then the reagent hydrocarbon. APCI is considered a soft ionization technique forming protonated molecular ions with minimal fragmentation. Ionization in this source does require a product to have a greater proton affinity then water clusters, which are the reagent ions. Water clusters with the product molecular ions are also observed complicating the spectra. Products are identified using the fragmentation patterns obtained by MS/MS scans. MS/MS scans also provide the ability to monitor fragmentation ions to distinguish between products of the same molecular weight. Gas phase product analysis is carried out online throughout a reaction allowing products to be monitored with time. Particle phase samples are collected on filter samples, which are introduced into the TAGA by thermal desorption post reaction. The utilization of multiple analysis instruments is allowing for a more

complete interpretation of reaction events. APCI-MS is showing excellent promise for product identification, requiring no chemical work up of samples prior to analysis. In the future it is desired to simplify the MS procedure by introducing online particle analysis.

3DPA1.13

Implementation of a coupled atmospheric-hydrological modeling system for real-time flood forecasts over the Huaihe River Basin, China

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Severe floods caused by heavy precipitation have posed a serious problem for all seven major river basins in China in the past and continue to do so. The Huaihe River Basin (270,000 km^2) is located between the Yellow and Yangtze Rivers, and has been suffering from flood disaster for centuries because of its geographical location and unique topographical feature. An accurate and timely flood warning system can help to minimize flood damages. We have developed and implemented a coupled atmospheric-hydrological modeling system over the Huaihe River Basin for predicting severe precipitation and real time flood forecast. The system consists of a high-resolution regional atmospheric model MC2 (Canadian Mesoscale Compressible Community) that is one-way coupled to two hydrological models (Chinese Xinanjiang hydrological model and Canadian Land Surface Scheme) for runoff generation; the Clark unit hydrograph and the Muskingum-Cunge channel routing method are used for flow routing to obtain hydrographs at selected basin control points. The system has been implemented over the basin and tested using hydro-meteorological data from 1998 and 2003 flooding seasons. A good result was obtained in the hydrological simulations as revealed by the Nash-Sutcliffe coefficients for both flooding seasons of 1998 and 2003. The system was then run in a real time flood forecast mode for the 2005 flooding season (May 1 to October 31). We updated both precipitation and flood forecasts at 8:00 GMT every 24 hrs. We first used the latest rain-gauge precipitation to correct errors of MC2 precipitation in the past 24 hrs; we then used rain-gauge precipitation and MC2 forecast to drive the hydrological model with a lead time up to 96 hrs. The forecasts were sent to the Chinese authority through Internet for consideration in the process of decision making should emergency situations emerge. We successfully forecasted the July 4 to 15 severe flood event with flood lead time up to 72 hrs. The forecast flood peak value and timing errors were less than 14% and 5 hrs. The encouraging result obtained in this study demonstrates the potential of using mesoscale model precipitation for real time flood forecast, which provides a longer flood lead time compared to many traditional methods.

4DPA6.17

The Composition of Secondary Organic Particulate Matter from the Photo-Oxidation of Meta-Xylene

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The particle phase products from the oxidation of atmospherically important hydrocarbons are not well known. We are studying the oxidation of specific hydrocarbons in a photochemical flow reactor. We can either collect the particulate phase products on filters for subsequent product identification or use a newly developed counter-current parallel plate membrane denuder where the particulate matter is sent directly to APCI MS/MS analysis.

The reaction being studied is the HO initiated oxidation of meta-xylene. The HO radicals are generated by the photolysis of isopropyl nitrite in the presence of NO and the residence time in the reactor is approximately 4 minutes. Products in the particles that are collected on a quartz fibre filter can be identified by two mass spectrometric techniques. In the first, the sample is extracted in solvent and analysed by a conventional GC-MS. In the second the sample is evaporated into the APCI source of a Sciex TAGA 6000E triple quadrupole mass spectrometer. In addition, predictions of the species in the particle phase are made using a chemical kinetics model based of the Master Chemical Mechanism.
The GC-MS identifies a number of products, through library spectra. Few of these products can be confirmed by the MS/MS capability of the TAGA 6000. Similarly none of the major products predicted by the model have been identified. The TAGA 6000 has independently identified a number of products. There are clearly shortcomings in our knowledge of the products of meta-xylene oxidation and their vapour pressures. The identification work is ongoing.

4B1.7
Photochemistry of Polycyclic Aromatic Hydrocarbons on Ice
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The kinetics of anthracene photodegradation on ice were measured using laser induced fluorescence detection. Both direct and indirect photolysis were observed; degradation rates increased in the presence of adsorbed nitric acid. The dependence of direct and indirect photodegradation processes on the wavelength of irradiation was measured, as was the dependence on temperature at values near freezing. These studies were performed both on pure ice and in the presence of organic contaminants.

3DPA2.6
Ground-based measurements of atmospheric column densities made with PARIS-IR during the Canadian Arctic ACE Validation Campaigns in 2004 and 2005
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As part of the Canadian Arctic ACE Validation Campaigns (February 22 – March 8, 2004 and February 21 – March 9, 2005), solar absorption spectra were recorded using the Portable Atmospheric Research Interferometric Spectrometer for the Infrared (PARIS-IR) at the Arctic Stratospheric Ozone (AStrO) Observatory near Eureka, Nunavut (80.0ºN, 86.4ºW). AStrO is now called the Polar Environment Atmospheric Research Laboratory (PEARL). The PARIS-IR is a ground-based version of the high resolution (0.02 cm^{-1}) Atmospheric Chemistry Experiment - Fourier transform spectrometer (ACE-FTS) on-board the Canadian scientific satellite, SCISAT-1. It has the same spectral coverage (750 – 4400 cm^{-1}) as ACE-FTS, which can record absorption features from most of the major atmospheric trace gases in one measurement scan. Total columns of about ten atmospheric species have been retrieved using the SFIT2 program which uses Rodgers' Optimal Estimation approach. Characterization of the retrieved column densities has been performed through averaging kernel calculations, and the error budget has been determined. Finally, comparison of the partial and total columns has been made with those from the ACE-FTS and the DA8 Fourier transform spectrometer stationed permanently at AStrO/PEARL and operated by the Meteorological Service of Canada.

4B3.5
What controls the atmospheric CO2 response to surface nutrient depletion ?
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Iron fertilization of the high-nutrient low-chlorophyll ocean areas has been proposed as a mechanism to decrease atmospheric CO_2 levels through the associated increase in biological production. In the present work we study the impact of increasing biological production on atmospheric pCO_2 in the Princeton GCM. The method used is to deplete (i.e., force towards zero) nutrients in large ocean areas and convert them to export production.
Here we show how the uptake of atmospheric CO_2 following nutrient depletion depends on the region depleted, gas exchange rate, ice, and oceanic circulation. We show that the Southern Ocean (and in particular the Antarctic region south of the Polar Front) is the most important area for CO_2 uptake in all models studied. Depleting surface nutrients changes both deep preformed nutrients and the CO_2 disequilibrium at the ocean surface. We examine how these two effects contribute to changes in atmospheric pCO_2.
We show that in models without ice and with infinitely fast air-sea gas exchange, the change in preformed (or remineralized) nutrients is an excellent index for the atmospheric pCO_2 change. In models with ice and finite gas exchange, the surface to deep *DIC* gradient is a better index for atmospheric CO_2 change.
Changes in diapycnal mixing or Southern Ocean winds significantly change both global preformed nutrient concentration and the surface CO_2 disequilibrium, thus changing atmospheric pCO_2. In conclusion, ocean physics and the details of the air-sea gas exchange mechanism are crucial in determining the atmospheric pCO_2 response to surface nutrient depletion.

1C1.1 **INVITED / INVITÉ**

Mapping surface spectral albedo over Canada from historical and modern sensors: Techniques, issues and data availability

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Surface albedo is one of the key parameters of the Earth climate system. It determines the absorption of solar radiation by the surface and, therefore, influences the energy exchange, hydrology, and biological processes. Surface spectral albedo and bi-directional reflectance distribution function (BRDF) are also important boundary conditions required for climate simulations, atmospheric radiative transfer modeling and remote sensing studies. This is the basic input information for retrieval of canopy structure and surface conditions. Variations and trends in the surface albedo serve as indicator of climate change impacts on terrestrial and aquatic ecosystems.
Overview of the work on mapping Canada-wide surface albedo at the Canada Centre for Remote Sensing of the Department of Natural Resources Canada (NRCan) is presented. The basic steps employed in retrieval of surface albedo from the top-of-the-atmosphere measurements are described. They include sensor calibration, cloud screening, atmospheric correction and BRDF shape retrieval. Three sources of spectral albedo information are considered: historical AVHRR observations since early 80's, VGT/SPOT data from 1998 and MODIS data from 2000. Time series of broadband albedo available from the Earth radiation budget missions such as ERBE, ScaRaB and CERES are also described.
Validation approach and results obtained by up-scaling of high-resolution imagery to medium and coarse resolution data are described. Historical albedo data series and trends derived from AVHRR and MODIS over Canada are presented. Surface albedo datasets over Canada are available data from NRCan public archives http://geogratis.cgdi.gc.ca/download/EO_Data/.

4C2.3

Application of a nested configuration of the CMC ocean wave model system during the DND's SISWS exercise

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During the period 12-19 September 2005, the Department of National Defence (DND) conducted an exercise at Osborne Head about 20 km east of Halifax, Nova Scotia. The objective of the exercise was to assess the impact of the marine environment on its Shipboard Integration Sensors and Weapons Systems (SISWS) Technology Demonstration Program (TDP). The ship used was the CFAV Quest and the test area covered a 200 km x 200 km square centred on Osborne Head. The Canadian Meteorological Centre (CMC) agreed to provide nearshore shallow water wave forecasts of the sea state conditions which seem to have an important effect on the operations of some of the DND's systems. The wave models used for this exercise were the WAM Cycle-4.5 (hereafter referred as WAM4.5) and the coastal model SWAN Cycle-III version 40.41 (hereafter referred as SWAN). The wave model set up for this exercise includes a 0.5^{o} coarse grid WAM4.5, a 0.1^{o} fine grid WAM4.5 nested inside the coarse grid and a 0.05^{o} extra fine grid WAM4.5 and SWAN, both of which are nested within the fine grid. The outputs from the WAM4.5 and the SWAN at three grid resolutions are validated against available observations from moored buoys and against two additional buoys deployed in the SISWS area. The results from this study assessing the performances of the wave models at various grid resolutions will be presented at this Congress.

3DPA1.9
GEM-LAM and MC2 simulations for a sea fog case study at Lunenburg Bay
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In Atlantic Canada advection of sea fog accounts for most fog observations at inland stations where the more common of two major types of sea fog forms when warm moist air moves over colder water. A case study spanning 4 days from 03 to 07 October 2005 was selected, where GOES images indicated fog banks unobscured by higher level clouds and the synoptic patterns were typical for sea fog formation off Nova Scotia.

Earlier modelling results indicated better verification scores between analyses and MC2 compared to archived GEM forecasts, and qualitative improvements in depicting sea fog compared to satellite imagery. MC2 experiments at 9km, 3km and 1km resolutions showed minor improvements in resolving fog indicators, but also demonstrated sensitivity to insufficiently measured moisture fields over the Atlantic Ocean. A related MC2 study on arbitrary bogusing of upstream moisture fields to saturation conditions indicated that in some cases, oceanic fog indicators downstream became more widespread and realistic.

Current results with GEM-LAM using the 15km regional settings indicate that while dew point spread is reasonably modelled, liquid condensate is somewhat underpredicted in both volume average and spatial distribution. Simulations using the same settings with MC2 show slight qualitative improvements in resolving fog indicators, but compared to Lunenburg Bay fog measurements both GEM-LAM and MC2 forecasts have limited accuracy. Further work on refining physics parameterization selections and higher resolution experiments for GEM-LAM is underway.

4DPA6.28
Mercury in the North Americian Atmosphere
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Mercury contamination of the ecosystem has been observed in areas far from anthropogenic sources. Canada and the United States have signed protocols on the control of mercury emission and also have begun to develop mathematical models of its chemistry and long-range transport to provide the scientific basis for control strategies. In the work to be presented here, we will describe the development of one such model and describe its use to assess the behaviour of mercury in the atmosphere of North America.

The model development was based on the US EPA's *MM5*/*SMOKE*/*CMAQ* chemical transport modelling system. We added to this a model that computes the emission of mercury from natural sources (vegetation, soil and water). These natural emissions were combined with anthropogenic emissions using the *SMOKE* emissions preprocessor. Since these emissions included all sources of mercury, the simulations based on them have a higher absolute accuracy than those based on anthropogenic emissions alone.

We will report model calculations for different scenarios including the reduction/cancellation of anthropogenic/natural mercury emissions, change of mercury boundary conditions, and transboundary transport. We examined the effects of these scenarios on the atmospheric concentration of mercury and the deposition of mercury in Ontario. Comparisons were made between anthropogenic emissions and natural emissions for different locations and also for different seasons. Natural emissions were observed to contribute significantly to total mercury emission in the region. The natural mercury emission fluxes and mercury air concentrations obtained from the simulations were in good agreement with measurements.

2B1.6
Wave Forcing, Parameterization, and the Breakdown of Newton's Third Law
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Current parameterizations of gravity-wave drag (GWD) in general circulation models (GCMs) of the Earth's atmosphere explicitly conserve wave pseudomomentum flux and, therefore, satisfy Newton's Third Law. This approach assumes a basic-state flow that is horizontally uniform and it allows a direct connection between wave dissipation and wave-induced forcing of the flow. When the horizontal structure of the basic-state flow is no longer uniform this approach fails. In this instance the more fundamental principle of wave action conservation must be invoked. In this more general framework one can no longer associate all wave-induced forcing with wave dissipation. Newton's Third Law may be violated and when it is the basic-state flow will be subjected to wave induced forces arising from wave dynamics that are conservative rather than dissipative in nature (Buhler and McIntyre 2005). In this study we reformulate a current parameterization of orographic GWD (Scinocca and McFarlane 2000) to allow horizontally non-uniform flow and to employ wave action flux, rather than pseudomometum flux, as its primary conserved variable. The impact of this new formulation is investigated by offline calculations and fully interactive GCM simulations.

1DPA2.24
The Atmospheric Chemistry Experiment (ACE): Recent Validation Results
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The Atmospheric Chemistry Experiment (ACE), also known as SCISAT-1, is a Canadian scientific satellite to perform remote sensing measurements of the Earth's atmosphere. It was launched on August 12, 2003 and has been operational for the past 2 years. The primary instrument on-board SCISAT-1 is a high-resolution (0.02 cm^{-1}) Fourier Transform Spectrometer (ACE-FTS) operating between 750 and 4400 cm^{-1}. It also contains two filtered imagers to measure atmospheric extinction due to clouds and aerosols at 0.525 and 1.02 microns. The secondary instrument is a dual UV-visible-NIR spectrophotometer called MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) which extends the wavelength coverage of the mission into the 280-1030 nm spectral region.

The primary measurement technique for the ACE instruments is solar occultation. From these measurements, altitude profiles of atmospheric trace gas species, temperature and pressure are obtained. The 650 km altitude, 74 degree circular orbit provides global measurement coverage with the majority of measurements occurring in the Arctic and Antarctic regions. The primary goal of the ACE mission is to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, with a particular focus on the Arctic region. The current status of the validation comparisons with other satellite remote sensing instruments will be presented in this paper.

4C4.1
Changes in temperature and precipitation extremes in the IPCC ensemble of global coupled model simulations
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Temperature and precipitation extremes and their potential changes in future are evaluated in the an ensemble of global coupled climate models participating in the Intergovernmental Panel on Climate Change (IPCC) diagnostic exercise for the Fourth Assessment Report (AR4). Climate extremes are expressed in terms of 20-yr return levels of annual temperature maxima and minima and 24-hr precipitation rates. The simulated changes are documented for years 2046-2065 and 2081-2100 relative to 1981-2000 in experiments with the SRES B1, A1B and A2 emission scenarios. Overall, the climate models simulate present-day warm extremes reasonably well on the global scale, as compared to estimates from reanalyses. The model discrepancies in simulating cold extremes are generally larger than those for warm extremes, especially in the sea-ice covered areas. Simulated precipitation extremes are plausible in the extratropics but uncertainties in extreme precipitation are very large in the tropics. Changes in warm extremes generally follow changes in the mean summertime temperature. Cold extremes warm faster than warm extremes by about 30-40š&, globally averaged. The excessive warming of cold extremes is generally confined to regions where snow and sea-ice retreat with global warming. Relative changes in the intensity of precipitation extremes generally exceed relative changes in mean precipitation, particularly in the tropics and subtropics. Waiting times for simulated present-day extreme precipitation events are reduced almost everywhere up to a factor of 2 in the middle of the 21st century, on average.

4C1.6
Measurements of the Kinetics of OH Radical Uptake on Micron-Sized Liquid Aerosols
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We will report the development of a new kinetic flowtube apparatus designed to study the reactions of radicals with model atmospheric aerosols and the results of initial measurements of

the uptake of OH radicals on liquid aerosol droplets. The apparatus consists of a low pressure (30-35 Torr) aerosol source connected to a kinetic flowtube (flow velocity ~ 10 m/s). Particle size distributions are determined by measuring IR spectra across the flow section and radical concentrations are monitored using a chemical ionization mass spectrometer. The mean sizes of the aerosol droplets ranged from 1 to 6 m.
In this presentation, we will report room temperature measurements of the reactions of OH radicals with pure water droplets and with a solution of an organic surfactant, sodium oleate. OH uptake on these liquid aerosols was measured by monitoring OH radical concentration as a function of the sizes and concentrations of the aerosols. Initial experiments show that the OH uptake coefficient on these liquid aerosols is on the order of 10^{-3} and that the heterogeneous reaction rate increases with the concentration of sodium oleate. The atmospheric implications of these results will also be discussed.

4DPA6.22
How the aerosol substrate influences the heterogeneous ozonation reactions of surface-bound PAHs
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The atmospheric fate of polycyclic aromatic hydrocarbons (PAHs) continues to garner research attention because of their carcinogenic and mutagenic characteristics. To this end, we have been exploring the chemical and physical mechanisms that control the fate of these compounds in the atmosphere. There is increasing evidence that the Langmuir-Hinshelwood mechanism governs the reaction of surface-bound PAHs and gas-phase ozone. For example, we demonstrated, in our offline studies, that the reaction of benzo[a]pyrene and ozone on organic aerosols proceeds by the Langmuir-Hinshelwood mechanism and that the rates of the reaction increase at higher relative humidites. Additionally, we also performed product studies investigating the reaction of surface-bound anthracene and gas-phase ozone, providing further evidence that the Langmuir-Hinshelwood mechanism governs reactions of this type. To complement these studies, we developed an aerosol flow tube apparatus coupled to a mass spectrometer to perform online kinetic studies of surface-bound PAHs and gas-phase ozone on sub-micron sized liquid aerosols. We present the results of these studies and discuss their atmospheric implications.

2B4.6
Empirical probabilistic seasonal temperature forecasts in Canada
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A method for constructing empirical probabilistic seasonal temperature forecasts in Canada is proposed. The method exploits a statistical relationship between seasonal mean surface air temperature in Canada and near global sea surface temperatures observed in months prior the forecast season. The statistical model is formulated in terms of multiple linear regression of local air temperature on the leading (co)variability modes of the ocean temperature. Probabilistic 3-category forecasts for below normal, near normal and above normal categories are derived by employing a normal distribution approximation of the climate noise on seasonal time scales. Forecast skill evaluation approximates an operational mode where no future information is used in the development of statistical seasonal hindcasts. Therefore artificial skill enhancement that is possible in some validation techniques such as cross-validation is avoided. The 20th century empirical deterministic and probabilistic temperature hindcasts in Canada are best skillful in colder seasons for time leads up to several months. Lower or no skill is found in warmer and transient seasons. The same technique is also applied for seasonal precipitation in Canada but

with only little success. Seasonal precipitation forecasting in Canada remains a challenging task. The proposed method can serve as a benchmark for validating probabilistic forecasts produced with numerical models.

3DPA1.6
excitation and dispersion of Rossby wavetrain on the polar jet by an extra-tropical transition of a hurricane

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Recent studies have indicated that the excitation of Rossby wavetrain on the polar jet may affect high-impact weather downstream. Extratropical cyclone development was mentioned as one possible triggering mechanism and a future research goal. The present work investigates a flow setting where a positive potential vorticity anomaly, associated with an extra-tropical transition of a hurricane, is located in the vicinity of the polar jet.
Numerical experiments have been conducted with the aid of a mechanistic model (shallow water, quasi-geostrophic, f-plane) in order to determine the nature of the interaction between the two vortices. The experiments will reveal the robustness of the model for the simulation of this problem in the sense of retaining the essential characteristics – excitation of a propagating Rossby wavetrain on the potential vorticity gradients of the jet. The influence of the cyclone's intensity and size on the wavetrain's amplitude and phase speed is discussed.
The validity of the simulation is tested through comparison to observed cases of hurricane-polar jet interaction.
Experiments with a large range of spatial and temporal resolution are made in order to determine the resolution at which the exited waves are adequately resolved. Comments are made on the importance of these results to the skill of today's forecast models.

4DPA6.14
Modeling study of ice formation by bacteria in warm-based convective cloud

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Modeling studying on ice formation by bacteria in warm- based convective cloud

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Bacteria have been recognized as cloud condensation nuclei (CCN), and certain bacteria, commonly found in plants, have exhibited capacity to act as ice nuclei (IN) at temperatures as warm as -2 ºC. These ice nucleating bacteria are readily disseminated into the atmosphere and have been observed in clouds at altitudes of several kilometres. It is noteworthy that over 20 years ago, one assumed the possibility of bacterial transport and their importance into cloud formation process, rain and precipitation, as well as causing disease in plants and animal kingdom. We used a 1.5-D cumulus cloud model with the CCOPE 19th July 1981 case and the observed field profile of bacterial concentration, to simulate the significance of bacteria as IN through condensation freezing and immersion freezing mechanisms. Based on the concentration of ice active bacteria between -3 °C and -8 °C, ice active bacteria should have a great influence on the ice crystal multiplication process. This may have significant implication in understanding of

climate. In this paper, we will present our results on the role of bacteria as active ice nuclei in the developing stage of cumulus clouds, and their potential significance in atmospheric sciences.

1C2.8
An Automated Synoptic Climatological Procedure to Predict Rainfall: An Application to London, Ontario, Canada
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An automated synoptic weather typing and logistic regression analysis were applied together to predict the occurrence of rainfall events. The weather typing was developed using principal components analysis, average linkage clustering procedure and discriminant function analysis to classify the weather types that were most likely to be associated with rainfall events at the city of London, Ontario. Meteorological data that was used in the analysis included hourly surface observations from the London International Airport and eight atmospheric levels of 6-hourly NCEP-NCAR upper-air reanalysis weather variables for the warm months (April–November) of 1958–2002. The data were divided into two parts: a developmental dataset for construction of the model and an independent dataset for validation of the model. Eleven years (25% of the total years) were randomly selected to validate weather typing and rainfall prediction model.

Stepwise logistic regression was performed on all days within the rainfall-related weather types to analytically determine the meteorological variables that can be used as forecast predictors for the likelihood of rainfall occurrence. In addition to a variety of surface and upper-air weather variables, many critical atmospheric stability indices (e.g., stability, total, and lifting indices) were used as predictors. The indices are commonly used by Environment Canada and the meteorological community in forecasting heavy rainfall associated with convection. The preliminary results show that the model is able to identify the occurrence of rainfall events. For example, using logistic probability of 0.6 as a cutoff, the procedure was able to identify 85% and 97% of total rainfall events for daily amount greater than trace and 24.9 mm, respectively. Using the probability of 0.9 as a threshold, the model was able to correctly identify 1307 rainfall events, while yielding only 34 false alarms, resulting in a post-agreement of 97.5% and a false alarm rate of 2.5% for development dataset. The corresponding post-agreement and false alarm rate for validation dataset were 86.5% and 13.5%, respectively.

The statistical procedure is being extended to other locations in Ontario. This study has further potential to be adapted to analyze extreme rainfall-related flooding risks and the possible impacts of climate change.

3DPA4.1
A Synoptic Weather Typing Procedure to Assess Possible Impacts of Climate Change on Heavy Rainfall: An Application to London, Ontario, Canada
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The overarching purpose of this study was to estimate changes in occurrence frequency of future heavy rainfall events under climate scenarios for London, Ontario. Automated synoptic weather typing (principal components analysis, an average linkage clustering procedure, and discriminant function analysis) integrating with regression analyses was applied to downscale GCM scenarios to estimate future weather types and frequency of future heavy rainfall events. Statistical downscaling methods were used to downscale GCM scenarios for three Canadian GCMs (CGCM1 IPCC IS92a, CGCM2 IPCC SRES A2/B2), one U.S. GCM (GFDL-CM2.0 IPCC SRES A2), and one Germany GCM (ECHAM5/MPI-OM IPCC SRES A2). The discriminant function analysis was then used to project the future weather types. Two independent approaches were used to assess climate change impacts on heavy rainfall for three-time windows (2010–29, 2041–

60, 2070–89) for Canadian GCMs and two-time windows (2046–65, 2081–2100) for U.S. and German GCMs. The first method depends on changes in the frequency of future weather types alone. The results from the historical analysis showed that the number of within-weather-type rainfall days above the critical rainfall values (e.g., 15, 25 mm) is usually proportional to change in frequency of the rainfall-related weather types. The second method uses within-weather-type rainfall prediction algorithms to take into account not only changes in frequency of future rainfall-related weather types but also changes in future weather characteristics. The historical runs (1961–2000) of the five GCMs were also downscaled and used for correction of the GCM model bias. Preliminary results show that under climate change, frequency of the future rainfall events could increase in the middle and later part of this century.

4DPA6.13

Modeling the Transport, Transformation and Deposition of PCBs and PCDD/Fs in North America

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PCBs, PCDDs and PCDFs are persistent organic pollutants (POPs) that are bioaccumulative and toxic. Many are semi-volatile, existing in the atmosphere in both gaseous and aerosol phases. They can be transported in both forms over long distances before being deposited by dry and wet processes to the surface. The Waterloo Center for Atmospheric Sciences (WCAS) has developed a model based on the US EPA's *MM5*/*SMOKE*/*CMAQ* system to describe the atmospheric chemistry, transport and deposition of these POPs. In our model, the PCBs and PCDD/Fs were speciated into 22 and 17 congeners respectively using the *SMOKE* emission preprocessor. The *CMAQ* model was modified to include the transport, diffusion and deposition of the speciated POPs and new *CMAQ* model components were created to describe their gas/particle partitioning and their chemical reactions with OH radicals. In this presentation, we will report simulations of the atmospheric behaviour of these POPs for the year 2000 in a domain covering most of North America, with a particular focus on the deposition flux to the Great Lakes. we will also report the quality of the simulations, evaluated by comparison with monitoring data.

4DPA8.7

The Shoaling of an Internal Solitary Wave: Comparisons between Weakly and Fully Nonlinear Numerical Models

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Internal solitary waves (ISWs) are frequently observed close to regions of steep topography in the ocean. ISWs play a very important role in mixing and energy dissipation, because they often have large amplitude and are very energetic. Here the shoaling of an internal solitary wave crossing a continental slope is studied in the case of a two-layer fluid with constant upper-layer thickness. Comparisons are made between fully nonlinear numerical simulations and the prediction of weakly nonlinear shoaling wave equations, which include second-order nonlinearity. Two versions of the modified Korteweg-de Vries (mKdV) equation are used. An idealized continental slope with constant gradient is considered. The shoaling of internal solitary waves is studied for both slowly varying bathymetry and rapidly varying bathymetry. Since directly solving the fully nonlinear equations is very time-consuming, one of the aims of this research is to determine to

what extent the mKdV equation gives a satisfactory prediction of the properties of shoaling waves leading to the development of improved models.

2C2.1
Beyond the Gulf Coast: Impacts of the Record-breaking 2005 Hurricane Season on Eastern Canada
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Tropical cyclones pose an annual threat to land masses in the western North Atlantic basin. The most recent example of this profound threat is the record-breaking 2005 hurricane season, in which 27 named storms were recorded in the Atlantic basin. However, the potential danger presented by tropical cyclones that transition into extratropical cyclones at higher latitudes is often overlooked. Occurring mainly during the late summer and early autumn, these storms can have a significant impact on the weather of Eastern Canada, especially in terms of heavy precipitation. Therefore, it is crucial to examine these dangerous cyclones within the context of the unprecedented 2005 tropical season.
Eight of the twenty-seven named tropical cyclones from the 2005 Atlantic hurricane season impacted Eastern Canada, as either transitioning or transitioned systems. Dynamical structures and precipitation distribution analyses will be presented for these storms from a quasi-geostrophic perspective, utilizing both the operational GFS initial analyses products and the North American Regional Reanalysis (NARR). Particular attention is given to the transitions of Hurricanes Katrina and Rita, which after devastating the Gulf Coast region, were responsible for large amounts of precipitation in the Eastern Canada region.

4B3.6
Microbial Dynamics in the Upper Ocean: Influence on the Cycling of Climate Active Gases
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Ecosystem processes are key determinants of upper-ocean biogeochemical cycles that are affected by climate, and in turn influence climate. The structure and activity of the lower food web has a large influence on the cycling and flux of key biogeochemical and climatically important properties, and the air-sea exchange of these properties. Heterotrophic marine microbes, such as bacteria and microzooplankton, mediate both the transformation both organic matter, and the production and cycling of key climate-active gasses such as CO2, N2O, and dimethylsulfide (DMS). As part of the Canadian Surface Ocean Lower Atmosphere Study, we characterized the seasonal and spatial patterns of microbial food web structure and dynamics in relation to the cycling of important climate gasses in five different biogeochemical provinces of the Western North Atlantic and in the eastern subarctic Pacific. In collaboration with other groups within Canadian SOLAS, we found that the production of CO2, and the dynamics of DMS were dominated by bacteria and heterotrophic protists, and that the variations in physical forcings and temperature control community structure and activity. The results of these studies are used to test the hypotheses that different food web structures and characteristics in the contrasting biogeochemical provinces will lead to distinct pattern in the cycling of these gasses, which in turn has important feedbacks on climate.

1C3.5
Balanced-unbalanced interactions in synoptic-scale flow
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The parameterisation of unresolved waves is an important problem in atmospheric and oceanic dynamics. While the feedback of the unbalanced motion on the balanced flow vanishes in quasi-geostrophic theory, it cannot be neglected in general. In this talk we examine the parameterisation problem in the context of rotating, stratified turbulence. Using a three-dimensional Boussinesq model, we study the growth of ageostrophic perturbations to quasi-geostrophic flow. We show that there exists a range of Rossby and Froude numbers for which the behaviour is analogous to that of decaying homogeneous turbulence: the growth rate of the perturbation follows a 'pressureless' estimate and the eddy viscosity exhibits a self-similar structure in which interactions are predominantly confined to large horizontal scales. This remarkable simplification holds for Rossby and Froude numbers of O(1). Implications for atmospheric and oceanic modelling are discussed.

2C1.5
Diagnostics of CMAM-DA using simulations with ensemble perturbations
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Simulations with ensemble perturbations can be used as a diagnostics tool in order to identify and quantify the artifacts generated by the Data Assimilation (DA) system.When applied to the Canadian Middle Atmosphere Model (CMAM-DA), the method was able to quantify the effect of gravity wave removal due to the digital filter currently used in data assimilation. The effect is especially strong in the upper stratosphere and mesosphere, where the digital filter removes perturbations with horizontal wave numbers higher than 12. The method was also used to quantify the effect of spurious wave generation due to the insertion of data in a case when the digital filter was not applied. Finally, the ability of another filtering method, IAU (incremental analysis updates), to suppress spurious gravity waves while preserving real gravity waves will be discussed.

2DPA6.13
Analysis of stratospheric chemistry using the GEM-BIRA coupled model.
S. Chabrillat [1], A. Kallaur [2], A. Robichaud [2], C. Charette [2], M. Charron [2], Jean de Grandpre [3], C. Cote [2], C. Xie [2], R. Menard [2]
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Analysis of stratospheric chemistry using the GEM-BIRA coupled model (S. Chabrillat, A. Kallaur, A. Robichaud, C. Charette, M. Charron, J. de Grandpre, C. Cote, C. Xie and R. Menard)

The Global Environmental Multiscale (GEM) model has been used to perform ozone interactive simulations of the stratosphere-tropospheric system. The model runs on 80 hybrid levels at 1.5 degree resolution (120x240) with a lid at 0.1 hPa. The stratospheric configuration of the model uses a radiative transfer scheme based on the Correlated-k Distribution (CKD) method and the Hines parameterization scheme for representing the momentum deposition induced by non-stationary gravity wave breaking. The on-line photochemistry module (BIRA) has been developed at the Belgium Institute for Space Aeronomy and implemented into GEM. It incorporates 57 constituents and 201 photochemical reactions including heterogeneous processes. The model has been run over seasonal time periods throughout the year 2003 using 3D Var

meteorological analyses refreshed every 6 hours. In this study, various constituents including ozone are compared against measurements from radiosondes and satellite instruments such as HALOE and MIPAS. The results indicate that the model can be used for investigating the nature of the different ozone forcings in the lower stratosphere region where most of the ozone trend uncertainties exist.

3DPA3.15
Vegetation feedback and vegetation-ocean synergy during Marine Isotope Stage 3/2 and the Mid-Holocene
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In model experiments for the Mid-Holocene (some 6000 years before present) it has been shown that the synergy between ocean and vegetation dynamics could explain the warmer winter temperatures in high northern latitudes during the Mid-Holocene, which occurred in spite of reduced winter insolation at the time. To investigate how the atmosphere-ocean-vegetation interaction differs during interglacial and glacial climatic periods, we study the interaction between climate system components during the Mid-Holocene and part of the last glacial period, Marine Isotope Stage (MIS) 3/2 (60.000–20.000 years before present).

Using the earth system model CLIMBER-2, we calculated the precipitation and temperature changes relative to pre-industrial conditions caused by the ocean feedback, the biogeophysical vegetation feedback, and their synergy for MIS 3/2. These factors were then compared to existing results for the Mid-Holocene.

During MIS 3/2, the simulated climatic changes caused by the ocean feedback were larger than those due to the vegetation-ocean synergy and the vegetation feedback combined. Compared with the Mid-Holocene, the simulated ocean feedback was much larger during MIS 3/2; however, the vegetation feedback and the vegetation-ocean synergy were of comparable magnitude during both climate periods, although, in the case of temperature, of opposite sign.

2C1.3
Validating CCM chemical tracer distributions in the extratropical UTLS
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The upper troposphere/lower stratosphere (UTLS) plays a key role in chemistry-climate coupling. Here, greenhouse gases such as ozone and water vapour are most effective in changing surface temperatures and hence climate. Climate change in turn has the potential through changing transport patterns and temperatures to sensitively alter tracer distributions in the UTLS. Chemistry Climate Models (CCMs) are used to quantify feedbacks between chemical constituents and climate. It is therefore essential to validate the models in this region in order to increase confidence in predictions of future climate. This is a key aspect of the SPARC CCMVal initiative.

Because of the scarcity of tracer measurements in the UTLS, diagnostics need to be robust and not prone to sampling issues. We propose several such diagnostics for characterizing the transport properties of CCMs in the UTLS. However, the model-measurement comparison is not trivial because every data set has its own limitations. For example, satellite measurements offer the benefit of global coverage but have resolution limitations for UTLS applications. On the other hand the model data set can be used to estimate the robustness of the diagnostic and its sampling requirements. In this study we compare results from the Canadian Middle Atmosphere

Model (CMAM) with both satellite and aircraft measurements in order to identify those diagnostics that are most useful for CCM validation in the extratropical UTLS.

1DPA1.13
Snow water equivalent in Canada: climatology and forecasting
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The current practice of snowfall forecasting in Canada is to determine the snow water equivalent (SWE) expected to precipitate using a numerical weather predication model and then multiplying this amount by a snow/SWE ratio to determine the forecast snow depth. The 10:1 "rule of thumb" is still widely used operationally as this ratio, even though it is well-known to introduce error in the forecasts because the density of snow is highly variable. Inaccurate snowfall forecasts can have high-impact to many sectors particularly snow-removal operations, transportation and the issuing of avalanche warnings. The objectives of this study are to explore the behaviour of snow/SWE ratio by developing a Canada-wide climatology of this quantity and examining the performance of an experimental Meteorological Service of Canada forecast algorithm over the winter 2004-2005 using several verification techniques.

2A1.2 **INVITED / INVITÉ**
Oceanic Convective Regions: a change in the way we view them
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While occupying a small fraction of the world ocean, convective regions play a fundamental role in climate. They contribute to the poleward heat transport through the release of large amounts of heat, during watermass transformation, and to the overturning circulation via the associated sinking of dense waters. In terms of climate variability, models link past and future climate change scenarios to changes in convection. Notwithstanding its relevance to climate, convection was, until recently, mostly viewed as an isolated process and little was known about its connection with the large scale circulation. We did not know, for example, where the sinking of dense waters occurred or how changes in convection would impact the overturning circulation. Thanks to the large amount of data collected over the last decade, however, and to the complementary numerical and laboratory experiments, a new paradigm for convective regions has emerged. It involves a convecting interior, a surrounding boundary current, where the sinking occurs, and a vigorous, eddy-mediated exchange between the two. This new paradigm will be presented here and supported through comparison with modern and historical data from the Labrador Sea, as well as high-resolution numerical simulations. It will be shown how, using this framework, one can address the causes for the variability of convection activity and its impact on the large scale circulation.

1DPA2.10
Global variability of the oxygen airglow
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Global variations of the O(^{1}S) and OH nightglow emissions are analyzed to study the transport of atomic oxygen in the upper mesosphere and lower thermosphere. The study utilizes the large data set for airglow emission rate provided from the observations of the Wind Imaging Interferometer (WINDII) on the Upper Atmosphere Research Satellite during Nov 1991- Aug 1997 and the numerical simulations of NCAR's Thermosphere Ionosphere Mesosphere Electrodynamics Global Circulation Model. By averaging the emission rates within each month, the climatology patterns of the airglow emission are obtained. A well-defined semi-annual

variation of emission rate is found in the equatorial region, caused by the semi-annual variation of the diurnal tide. At mid-to-high latitudes, the emissions exhibit an annual variation which appears to be a feature of the large-scale circulation. At mid-latitudes, both annual and semi-annual variations are seen, probably a combination of tidal influence and the large-scale circulation.

2C4.5
Statistical evidence for the effect of the Madden-Julian Oscillation on ENSO
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Using the Hilbert Singular Value Decomposition (HSVD) method, we analyzed the tropical Pacific surface zonal wind for the period 1981 to 2000 and defined a Madden-Julian Oscillation (MJO) index. With the newly-defined MJO index, we found: (1) Statistically significant relationships exist between the MJO index and ENSO (El Nino and Southern Oscillation) variability at time lags of 3-8 months (i.e., lagged relationships), with the maximum correlation appearing at a lag of 4-5 months; (2) Lagged correlations show a positive impact of MJO on ENSO - strong MJO activity occurs prior to El Nino whereas La Nina often follows relatively weak MJO activity; (3) The impact of MJO on ENSO is due mainly to the contribution of the Pacific MJO activity. A global MJO index that is affected by the Indian component of MJO activity is statistically uncorrelated to ENSO; and (4) The impact of MJO on ENSO is probably nonlinear, primarily through downwelling oceanic Kelvin waves and upwelling oceanic Rossby waves.

1C4.4
Extreme sea ice: modelling the conditions for development and stability of the Ward Hunt Ice Shelf
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The Ward Hunt Ice Shelf (WHIS) is located on the northern coast of Ellsemere Island in the Canadian Arctic. Unlike a 'conventional' ice shelf, it is not an extension of a terrestrial ice sheet. Rather, it formed in situ as frozen sea water (i.e. landfast sea ice) which subsequently thickened via both bottom and surface accumulation. The ice sheet is roughly 40m thick and has been in place for at least 3000 years.The question we are interested in is: how could such thick sea ice form? Elsewhere in the Canadian Arctic, such as at nearby Alert Bay, the landfast ice is seasonal and reaches a maximum annual thickness of only 2.5m or so. We use a one-dimensional thermodynamic sea-ice model to explore the range of meteorological forcing parameters that might lead to the formation and stability of thick (>20m),perennial landfast ice. We find combinations of lower temperatures, increased snowfall and increased cloudiness are capable of initiating an ice shelf. Such conditions might reflect local microclimate variations on northern Ellesmere Island and/or climatic conditions earlier in the Holocene.

4DPA7.4
Development of a 1-D Coupled Atmosphere-Ocean-Biogeochemical Model within the Canadian Surface Ocean Lower Atmosphere Study (SOLAS)
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As part of Canadian SOLAS we have developed a 1-D atmosphere-ocean-biogeochemical model to investigate the coupling between atmosphere-ocean exchanges and the planktonic ecosystem.

The atmospheric Single Column Model (SCM) is based on the Canadian Centre for Climate modelling and analysis (CCCma) Atmospheric General Circulation Model. The ocean component employs the General Ocean Turbulence Model (GOTM).

A 7-component ecosystem model is embedded in GOTM, which includes nitrogen, carbon, silica, oxygen and DMS (currently tested) cycling. The model is applied to C-SOLAS experiments performed at Ocean Station Papa (OSP):

1. Observations from the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) in 2002 combined with atmospheric reanalysis data (NCEP, ECMWF) were used to initiate and force the coupled physical model. We studied the models sensitivity to forcing, vertical resolution and timing of fertilization. Results show that during SERIES, shallow boundary layer heights occuring when DMS production was highest suppressed dispersion into the atmosphere, and that strength and length of the response to iron enrichment at OSP depend strongly on short term atmospheric conditions.

2. We simulated timeperiods of the North East Pacific SOLAS mooring, which has been maintained since September 2002. In addition to CTD recorders the mooring is equipped with Gas Tension Devices (4 depths), oxygen sensors (2) and fluorometers (2) for chlorophyll estimates. Here, we focused on the intercomparison of simulated and observed nitrogen and oxygen variability. A strong chlorophyll signal observed in summer 2003 and a weaker signal in May 2004 are shown to be explained by natural iron input either laterally or from below the mixed layer.

3C3.3

Implementation of an atmosphere-ocean-sea ice coupled model in the CMC-Meteorological Service of Canada operational forecast system

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Atmosphere-ocean-sea ice interactions are important in Eastern Canada due to the proximity of the North Atlantic Ocean, the Labrador Sea and the presence of three relatively large inner basins: the Gulf of St. Lawrence (GSL), Hudson Bay and the Great Lakes. These interactions influence the evolution of weather systems, as well as that of the ocean-ice regime. The work of

Pellerin et al. (2004) clearly showed the importance of the full interactive coupling between an atmospheric and a sea ice model over the Gulf of St. Lawrence (GSL) to obtain better atmospheric and sea ice forecasts over the GSL and in adjacent coastal areas.

The goal of this project is to implement a coupled system in the Canadian Meteorological Centre (CMC) operational forecast system for Eastern Canada in order to improve the meteorological, oceanic and sea-ice forecasts. For the atmospheric part, we use the Canadian operational model GEM (Coté et al. 1998) and for the oceanic part we use an ocean-ice model for the Gulf of St. Lawrence developed at the Maurice-Lamontagne Institute (Saucier et al. 2003). The coupling of the models is done through the surface fluxes with the OASISv3-Gossip2 coupler (Valcke 2004) developed at the European Centre for Research and Advanced Training in Scientific Computation (CERFACS). Gossip2 is a communication package using UNIX sockets. It has been developed at the RPN Centre (Recherche en Prévision Numérique, Environnement Canada). The project and preliminary results are presented.

1DPA2.13
The University of Toronto's Balloon-Borne Fourier Transform Spectrometer
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The University of Toronto's Fourier transform spectrometer (U of T FTS), derived from a Bomem DA5 Michelson-type interferometer, was rebuilt and flown on the Middle Atmosphere Nitrogen TRend Assessment (MANTRA) high-altitude balloon platform in September, 2004. The U of T FTS has a resolution of 0.02 cm^{-1}, a spectral range covering 1200-5000 cm^{-1}, and InSb and MCT detectors that measure simultaneously.

The spectrometer was originally built in the 1980s and purchased by the Meteorological Service of Canada. To prepare the instrument for flight, new software was necessary and was replaced by LabVIEW control software, creating a robust and easily-controlled instrument, adaptable to either remote control or lab-based work. The software contained accessible housekeeping information, downlink capability and an embedded scheduler. In addition to replacing the software, nearly all the original electronics were replaced using off-the-shelf components. The dynamic alignment system is the only original electronic system remaining. A small "delta-suntracker" was incorporated which facilitated alignment of the spectrometer with the balloon payload. A description of the refurbishment will be presented.

Despite balloon launch and gondola pointing system failures during the MANTRA 2004 campaign, two spectra were recorded on each detector during sunset from a float height of 35 km. The data indicate that the instrument performed well throughout the flight, and, had the payload pointing been under control, would have retrieved a full set of occultation data. The data

that were acquired will be shown. The spectrometer has since participated in a three-month-long ground-based FTS inter-comparison campaign, and some preliminary results from that comparison will be discussed.

3DPA5.4

Freshwater pathways of river runoff in the Arctic

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This poster presents a study of the relationship between the surface circulation regime of the Arctic and freshwater pathways of the Siberian shelf river runoff using the summer climatic atlas of the Environmental Working Group (1997). The decadal averaged circulation is diagnosed from 1950 to 1990 using the dynamic height data. It is found that the decades 1960 and 1980 are respectively anticyclonic and cyclonic. These observations are compared with the sea level gradient (SLG) index prediction derived from a barotropic model of the Arctic Ocean (Proshutinsky and Jonhson, 1997). The Siberian shelf freshwater pathways of river runoff are then related to these two typical circulation regimes. It is found that the freshwaters are hugging the coast towards the east during cyclonic regime, and are going off shelf through the transpolar drift during anticyclonic regime. These observations are coherent with model prediction of Newton (2001).

3B1.4

Continuous Temperature, Humidity and Cloud Liquid Profiling with Microwave Radiometer Profilers during Dynamic Weather Conditions

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Continuous temperature and humidity soundings up to 10 km height and one-layer cloud liquid soundings can be retrieved from ground-based multi-channel microwave radiometer observations during nearly all weather conditions. In contrast to radiosondes, the radiometric retrievals provide substantially improved temporal resolution but coarser vertical spatial resolution, which declines in proportion to the height above ground level. In this regard the retrievals more closely match the temporal and spatial resolution of numerical weather forecast models. Results of statistical comparisons between radiometric retrievals and radiosonde soundings show that radiometric retrieval errors are similar in magnitude to radiosonde representativeness errors (~2 K or better in temperature, ~1.5 g/m3 or better in water vapor density). Thus, continuous radiometric measurements can be used to improve numerical weather models in the interval between radiosonde soundings. We present example radiometric retrievals and comparisons with radiosonde soundings during a variety of dynamic weather conditions including fog, snowfall, rain, boundary layer turbulence and tropical storms.

4B2.3

Water Column Variability at the CASES Winter Station (Franklin Bay, Canada)

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The CCGS Amundsen overwintered in Franklin Bay from 29 November, 2003, to 1 June, 2004. CTD profiles were sampled at least every twelve hours through a moonpool between 3 December, 2003, and 29 May, 2004. Two hourly 13-h CTD time series were also obtained near consecutive maximums of spring and neap tides (on 6 and 13 February 2004, respectively). Salinity data show the usual winter convection and a set of winter "events", especially near 30 m, while the temperature at this depth was highly variable all winter. The 13-h time series present a large variability at 20-40 m, modulated by the neap-spring tidal cycle. The density stratification, essentially controlled by the salinity, shows a stable mixed layer but with tidal variations in thickness. In account of a weak temperature vertical gradient, turbulent temperature diffusion could be observed at the base of the mixed layer.

3C4.2

A test-bed of an Atlantic coupled meso-scale modeling system

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As a part of a multidisciplinary research initiative centered on Lunenburg Bay, Nova Scotia, we have been developing a real time coupled atmosphere/ocean/ecosystem prediction system for Atlantic Canada. The system is composed of at least 7 different numerical models, including three nested ocean models, a wave model and two types of ecosystem models. The atmospheric component is the Global Environment Multiscale (GEM) model (a 10 km grid extending along the eastern seaboard of the Atlantic, embedded with a 2.5 km grid centered on Nova Scotia). The GEM model configuration, coupling strategy along with preliminary results of a part of the coupled system will be presented.

3C3.4

Initiating an operational Canadian global assimilation and prediction capability for the coupled atmosphere-ocean-ice system

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(Presented by / Présenté par ***C. Harold Ritchie***)

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The Meteorological Service of Canada (MSC), the Department of Fisheries and Oceans (DFO), and the Department of National Defence (DND) all need the products and modelling capabilities that can be provided by an operational global coupled atmosphere-ocean-ice data assimilation

and prediction system. Argo floats, together with other data sets (e.g., altimeter, remotely sensed sea surface temperature, and tropical moored arrays) provide tremendous potential for the development of ocean data assimilation systems. An inter-departmental advisory panel (comprised of the authors listed above) developed recommendations for an operational Canadian coupled atmosphere-ocean-ice data assimilation and modelling capability. These recommendations have been accepted by senior departmental managers. In the past year agreement has been reached with the Mercator group to import their ocean data assimilation and prediction and install it at the Canadian Meteorological Centre as a starting point. Initial resources have been put in place for the establishment of three inter-related tracks: an operational track based on coupling with the Mercator system; a research and development track consisting of long-term government research and complementary academic research networks to develop and maintain a system tailored to Canadian needs in the longer term; and a products track to identify, develop and disseminate relevant products and outputs. The operational track is being built upon existing MSC infrastructure. This talk will provide an overview of the system and its applications, and will summarize progress to date and plans for the future.

1DPA4.12
Atmospheric Predictability with a Simple Model
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The prediction of the evolution of a nonlinear dynamic system from an initial condition with some uncertainties can be intrinsically limited by its dynamics. Lorenz (1969) and Leith (1971) explored the predictability of 2D turbulence and respectively found finite and indefinite predictability, a result of their different assumptions about the slopes of the energy spectra in the inertial range, and hence the dependence of error growth rate on spatial scale. In the atmosphere, the error growth rates on the smallest scales are much faster than those on larger scales and saturate quickly. Moreover, observational errors are finite. The Lyapunov exponent reflects the small-scale growth of infinitesimal errors, and is thus irrelevant to predictability. The Finite Size Lyapunov Exponent accounts for the dependence of error growth rate on error magnitude. Its successful application in simple low-order systems motivates our attempt to apply it into a simple model of 2D turbulence (Bartello and Warn, 1988). Energy injection and dissipation are introduced into the model to generate turbulent flows with different slopes of energy spectra. The FSLE is applied in these flows to study the corresponding predictability.

3B2.6
Global Energy Conversion Diagnosis Based on Wave-Mean-Flow Interactions and its Analysis of the Global Warming Simulation
Toshiki Iwasaki , Yasushi Mochizuki , Chihiro Kodama , Kiyotaka Shibata , Seiji Yukumoto
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A diagnosis scheme of the global energetics based on wave-mean-flow interactions is being developed for the purpose to analyze climate variability. In the new scheme, the use of mass-weighted isentropic zonal means leads us to a cascade type of the energy conversion diagram. This is very different from the Lorenz's four-box energy cycle. The preliminary analysis is made to clarify changes in the energetics due to the global warming.

1. Energy Conversion Cascade
The general circulation can be expressed as a cascade type of the energy conversion diagram. Wave energy (W) is defined as the sum of eddy available potential energy and eddy kinetic energy. Zonal mean available potential energy (Pz) is converted into zonal mean kinetic energy (Kz) through the mean-meridional circulation, and the zonal mean kinetic energy (Kz) is converted into wave energy (W) mainly through wave-mean-flow interactions.

Pz is effectively converted into Kz through the Hadley circulation and the extratropical direct circulation. About 60 % of mean kinetic energy Kz is converted into wave energy W. Residuals may be lost mainly through the surface frictions.

2. Analysis of the global warming
By mean of the new diagnosis scheme, we analyze a GCM experiment of the global warming. The increased CO2 affects the mean-meridional circulation, that is, enhances the Brewer-Dobson circulations in the stratosphere but suppresses extratropical direct circulation in the troposphere. This is closely related to reduction of the wave energy generation rates.

3B2.4
Changes in the Brewer-Dobson circulation due to the increased CO2 - Radiation and SST induced effects
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Many numerical experiments have shown that the increased CO2 enhances the Brewer-Dobson circulation (BDC) in the stratosphere. However, its mechanism is not clearly understood. The increased CO2 directly affects the stratospheric temperature through the radiation and may change the BDC. Another possible mechanism of the BDC change is that the increased CO2 slowly warms up the SST, changes the tropospheric temperature and affects the BDC through the modification of wave activities. Considering this, we attempt to separate Radiation-induced effect (direct effect) and SST-induced effect (indirect effect) by using atmospheric GCM.

In the upper stratosphere, both the direct and the indirect effects enhance the BDCs in the winter hemispheres. The enhancement of the BDC is stronger in the Northern Hemispheric winter than in the Southern Hemispheric winter. The large difference between the two hemispheres results from the wave activities of stationary waves. In both summer hemispheres, the indirect effects enhance BDCs. A Eliassen-Palm flux analysis suggests that the indirect effects enhance upward transient wave propagation from the troposphere to the stratosphere in both summer hemispheres.
In the tropical lower stratosphere, the indirect effect enhances BDC in DJF. It may be caused by the increased tropopause height or by the increased EP flux convergence in the subtropical lowermost stratosphere.

2DPA6.5
Seasonal and Interannual Variabilities of Energetics Based on Wave-Mean-Flow Interaction
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A diagnosis scheme of a cascade type global energetics based on wave-mean-flow interactions is being developed for the purpose to analyze the dynamics of mean meridional circulation. The zonal mean available potential energy (Pz) is converted into the zonal mean kinetic energy (Kz) through mean-meridional circulation while Kz is converted into wave energy (W) through wave-mean-flow interaction. The details are reported in this conference by Iwasaki et al.. We analyze the seasonal and interannual variabilities of the energetics using NCEP/NCAR reanalysis.

1.Seasonal variability
Pz and W become maximal in the boreal winter and minimum in the boreal summer. On the other hand, Kz has maximum in the boreal summer and local maximum in the boreal winter. Every conversion term has maximum in the boreal winter.

The wave energy in the Northern Hemisphere (NH) is about 1.5 times as large as that in the Southern Hemisphere (SH). One reason is that the mechanical wave energy generation term is larger in the NH than in the SH. Another is that the stationary ultra-long waves are considerably generated in the NH, whose dissipation time is relatively longer than that of transient waves.

2.Interannual variability
Pz and W slightly decrease in the last 3 decades, whereas the conversion term C(Kz,W) is almost constant over time. It suggests that the dissipation time is getting smaller, probably because stationary ultra-long waves are reduced in comparison with transient waves.

Further analysis is underway to study the Arctic Oscillation trend based on the new energetics.

4B1.2
Observational constraints on the chemistry and transport of an urban plume
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Detailed chemical and meteorological measurements at three sites located in the outflow of the Sacramento urban plume are used to constrain a Lagrangian model of the chemical evolution and transport of the plume. The model includes a detailed chemical mechanism, and uses a nonlinear least squares routine with inputs of key physical parameters and observations of speciated nitrogen oxides, volatile organic compounds, and ozone, to find optimal values for the plume dilution rate and average formaldehyde concentration. The analysis improves our insights into the non-linear processes controlling regional nitrogen deposition and photochemical ozone production, and allows us to make predictions about the response of the system to future perturbations such as climate change and suburban population growth.

1B2.7
Significant Summer Rainfall on the Canadian Prairies: Modes and Mechanisms 2000 - 2004
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This study analyzed 918 significant (>10 mm in 24 hrs) summer rain events from 2000 to 2004 to identify their mode (solely or partially convective versus non-convective), and the scale of their primary forcing mechanism (synoptic versus mesoscale). It asked the question: What exactly is the nature of summer precipitation on the Canadian Prairies? While common perceptions prevail, an objective answer to this question is a necessary prerequisite to improving forecast skill and the understanding of the meteorological processes responsible for summer droughts and wet periods. Daily rainfall and lightning maps revealed that most of the events (75%) were convective (i.e., lightning was recorded during the event), while 86% of the rainfall volume, a measure of the intensity of the events, was from convective events. Average monthly percentages varied. In June, 68% of the events were convective, in July 84%, and in August 73%. In June, 81% of the rainfall volume was from convective events, in July 94%, and in August 84%. The inter-annual range of rainfall volumes was 100 to 170 km3. The primary forcing mechanisms for non-

convective events were surface lows (24%), surface troughs (19%), and cold lows (15%). For convective events, the primary forcing mechanisms were mesoscale processes (30%), surface lows (15%), surface troughs (15%), and warm and cold fronts (both 14%). Cold low forced non-convective rains were 2-10 times more frequent in 2004 than any of the other years. 2004 was also a year that ended a multi-year drought.

3B1.1 **INVITED / INVITÉ**

The Canadian Network for the Detection of Atmospheric Change (CANDAC) and the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut

James R. Drummond , CANDAC Science Team
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CANDAC is a network of university and government researchers involved with the study of the atmosphere over Canada. Its major focus at the present time is the installation of PEARL at Eureka, Nunavut (80N, 86.25W). PEARL will provide a unique capability within Canada to conduct atmospheric research in the High Arctic, to provide data on the Arctic to inform policy-makers, and to train the next generation of researchers.

PEARL is situated 600m above sea level (asl), in a location that provides good "seeing" conditions for remote measurements of the middle atmosphere, such as infra-red spectrometers and lidars. Since it is fed with power from the Eureka weather station 15km away, it generates no significant particulates or effluent of its own and therefore offers an interesting site for the study of the atmosphere near the surface. The zero-altitude PEARL auxiliary laboratory (ØPAL) is situated by the weather station at sea-level and provides a second view of the atmosphere. By comparing measurements at ØPAL and PEARL, the lowest 600m of the atmosphere can be differentially probed.

PEARL has a permanent staff of two technicians on rotation – one of these is always a trainee - often a graduate student. The staff maintains the equipment under direction from the individual researchers in their home institutions. A geostationary communications link provides internet access and telephone communication.

This talk will discuss the PEARL laboratory and the opportunity it offers to Canadian researchers to train personnel and to conduct atmospheric research in Canada's High Arctic. This is particularly timely in view of International Polar Year (IPY) in 2007-2008.

CANDAC and PEARL are supported by the following organizations: Canadian Foundation for Innovation, Ontario Innovation Trust, Ministry of Economic Development and Trade (Ontario), Nova Scotia Research and Innovation Trust, Natural Sciences and Engineering Research Council, and the Canadian Foundation for Climate and Atmospheric Science. In-kind support is provided by the Polar Continental Shelf Program and Environment Canada.

The CANDAC Science Team comprises: James R. Drummond (1) Tom Duck (2), David Hudak (3), Alan Manson (4) , Bruce McArthur (3), Thomas McElroy (3), Norman O'Neill (5), Gordon Shepherd (6), Marianna Shepherd (6) , Robert Sica (7), James Sloan (8), Kimberly Strong (1), Kaley Walker (8), William Ward (9), James Whiteway (6). 1) University of Toronto, 2) Dalhousie University, 3) Environment Canada, 4) University of Saskatchewan, 5) Université de Sherbrooke, 6) York University, 7) University of Western Ontario, 8) University of Waterloo.

4DPA6.29

A 3-D Eulerian multimedia fate and chemical transport regional modelling system for pesticides

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Many pesticides have been identified by the US EPA as persistent, bio-accumulative, and toxic pollutants and concerns about their adverse effects on the environment have been expressed for many years. Due to their application in the past, significant pesticide residues remain in the soil and these can be emitted into the atmosphere, where they are transported over long distances and deposited far from where they were originally applied.

In order to investigate issues related to pesticides in the environment, we have developed a 3-D Eulerian multimedia regional fate and chemical transport modelling system based on the US EPA *MM5*/*SMOKE*/*CMAQ* chemical transport system, which we have coupled to *PEM*, a dynamic pesticide emission model that includes soil heat, moisture and pesticide transport. This modelling package takes into account the important physical and chemical processes related to pesticides in both the atmosphere and the soil, including emission, chemical reaction, atmospheric transport and deposition on regional or local scales. We have used this modelling system to carry out a study of the atmospheric behaviour of toxaphene, a persistent, toxic and bio-accumulative pesticide. The study was carried out for a 1 ½ year period from January 1, 2000 to June 30, 2001 and covers a domain that includes most of North America with a resolution of 36x36 km. Comparison of the modeled results with measurements shows very good agreement.

3DPA2.3

Observations of O3 during the Canadian Arctic ACE Validation Campaign 2006

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During spring 2006, nine ground-based instruments including the Portable Atmospheric Research Interferometric Spectrometer for the Infrared (PARIS-IR) took part in a measurement campaign to validate results from the Atmospheric Chemistry Experiment (ACE), a Canadian satellite mission to investigate the ozone depletion processes. Observations were performed at the Polar Environment Atmospheric Research Laboratory (PEARL) (80.05ºN, 86.42ºW, 610 m above sea level) and balloon-borne ozonesonde and radiosonde sensors were also flown. During the intensive phase of the campaign (from February 18 to March 9, 2006), the ACE instruments, ACE-FTS (Fourier Transform Spectrometer) and ACE-MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) performed solar occultation measurements over the Canadian Arctic. Preliminary comparisons of Arctic ozone columns from ground-based and balloon-borne and satellite-borne instruments will be presented. These observations will be used to validate measurements from the ACE satellite mission and to improve our understanding of ozone depletion processes.

3DPA1.12

Forward Lagrangian Stochastic Simulation of a Transient Source in the Atmospheric Surface Layer

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Simulations of a simple field experiment were conducted to evaluate the performance of the Lagrangian Stochastic model with respect to plume timing. We show that a forward Lagrangian Stochastic model simulates well the ensemble-averaged concentration transient due to a short time (5 min) point source in the uniform atmospheric surface layer. The second objective of this research, in keeping with the focus of plume timing, was to asses the usefulness of incorporating an algorithm to parameterise the ‘surface delays' experienced by particles in the unresolved layer beneath the trajectory reflection height, and the corresponding displacements experienced by these particles.

Model results were rather insensitive to the placing of the lower reflection boundary, and no definite benefit stemmed from including a parameterisation for unresolved delays/displacements beneath the lower boundary.

1DPA1.3
A fuzzy logic based analog forecasting system for ceiling and visibility
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WIND-3 is an analog forecasting system that makes probabilistic forecasts of cloud ceiling height and horizontal visibility at airports. For data, it uses a large data base of archived hourly observations, current observations (METARs), and model-based guidance. To find analogs, it uses a fuzzy logic based algorithm to measure similarity between past and present conditions (a composite of recent observations and model-based guidance). It uses the found analogs to make forecasts for the 0-to-24 hour projection period. WIND-3 has been tested by running continuously for over a year producing forecasts for all major Canadian airports, and it produces highly accurate forecasts, based on summaries of POD, FAR, and CSI statistics, and compared to benchmarks (persistence and TAFs). WIND-3 produces a large amount of information every hour which is challenging for forecasters to routinely factor into their forecasting decision-making processes. We will discuss how WIND-3 could be combined with complementary data from computer model post-processing systems at the Canadian Meteorological Centre and processed to into better decision-supporting guidance for forecasting weather at airports.

4C2.7
A comparison of resuspension mechanisms due to internal waves
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Internal waves in lakes and the coastal ocean can induce hydrodynamic instabilities in the bottom boundary layer that can both increase the bottom stress responsible for resuspending sediment into the bottom boundary layer and provide long-lived, coherent structures that can pump sediment out of the bottom boundary layer and into the main water column**.** In this talk we discuss nonhydrostatic numerical simulations of boundary layer instabilities in the footprint of internal waves for a variety of situations. In particular, we contrast our previous work on resuspension due to a solitary wave of elevation propagating against a barotropic background current with the boundary layer instability and resuspension events due to topographically generated internal waves. Furthermore, we discuss the differences between internal wave-induced boundary layer instability and the case of an internal wave interacting with a rough bottom. If time permits, we will comment on the numerical challenges that remain to be tackled before a well resolved simulation of sediment resuspension over an entire tidal cycle is possible.

1DPA3.5
Structure and Evolution of Extreme Winter Storms over Baffin Island
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Extreme winter storms affect all regions of the Arctic and can have hazardous impacts on society. Given the current significance as well as the possibility that the frequency and strength of extreme winter storms may change in the future, a better understanding is critical. To date, little research has been conducted on the detailed structure and evolution of extreme winter storms over Baffin Island. To begin to address this issue a small pilot project was conducted between 17 October and 28 November 2005 in Iqaluit, Nunavut during which time detailed observations of several winter storms were made. Weather balloons were launched into the storm systems at 3-4

hourly intervals to both characterize the vertical structure of the atmosphere and to identify the frontal properties of the storms. Detailed precipitation measurements (including the photographic identification of ice particle sizes and types, snow temperature, and snow density) were also made. Through an analysis of the upper air and surface data detailed information concerning the storms' thermodynamic, kinematic and moisture characteristics were made. Preliminary results, including an overview of the pilot project and an analysis of the data collected, will be presented. The knowledge and insight gained during this pilot field project also serves as a template for the Storm Studies in the Arctic (STAR) campaign that will take place in conjunction with IPY.

2B2.5
Properties of Northern Hemisphere Polar Stratospheric Clouds
James Sloan , I.L Galkina , M.N Eremenko , A.Y Zasetsky
(Presented by / Présenté par ***I.L. Galkina***)
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Polar Stratospheric Clouds (PSCs) are the locations for very important heterogeneous chemical reactions in the stratosphere. In particular, liquid and solid PSC particles are responsible for many of the processes that result in polar ozone depletion. The particle sizes and compositions of the PSCs are central parameters in the modeling of these processes and thus it is crucial to obtain accurate measurements of these properties. We have developed algorithms to retrieve this information from measurements made by the Atmospheric Chemistry Experiment Fourier transform spectrometer (ACE-FTS) and the associated imagers on the Canadian SCISAT satellite.
In this presentation, we will report our analysis of the measurements from a series of PSC observations in the Arctic made during the winter of 2005. The results will include a detailed analysis of several PSCs observed between 65°N - 76°N in January and February 2005. We report the compositions (Ice, Nitric Acid Hydrates, Supercooled Ternary Solutions, etc.) and the size distributions of the particles in the PSCs. The properties of the clouds are compared between January, when the maximum number of clouds occurs, and February, which is closer to the breakup of the Arctic Vortex. The results are considered in the context of the atmospheric dynamics and meteorological conditions during this period, which provide clues to the processes responsible for the PSC formation. The influence of these PSCs on ozone depletion in the Arctic stratosphere is also discussed.

4B2.7
Storm-Induced Circulation on the Meso-American Barrier Reef System during Hurricane Mitch
Liang Wang
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The main purposes of this study are to simulate circulation patterns around coral reefs of the Meso-American Barrier Reef System (MBRS) in Mexico-Belize-Honduras and to assess physical connectivity between different reefs of the MBRS. As such, the impact of short term events may be significant. Here, we study the impact of the category 5 Hurricane Mitch (1998) on MBRS circulation features using a triply nested-grid ocean circulation modelling system. The nested-grid system is based on CANDIE, a three-dimensional, z-level, ocean circulation model, and uses the two-way nesting technique based on the semi-prognostic method developed recently by Sheng et al. (2005). The nested-grid modelling system has three sub-components: an outer model covering the western Caribbean Sea, an intermediate model covering the southern MBRS and an inner model covering the coastal region off Honduras. The nested system is forced by NCEP wind stresses for the first 294 days and by an idealized storm wind forcing for the next 20 days. The nested system is also forced by the monthly mean surface heat and fresh water fluxes. The

salinity and extent of estuarine waters along the northern coast of Honduras are specified based on SeaWiFS ocean color images. The nested system generates strong divergent surface currents under the storm, intense near-inertial currents in the wake of the storm, and sea surface temperature cooling biased to the right of the storm track. The system also produces a strong estuarine jet extending from the coast into the deep waters off Honduras, which is consistent with the remote sensing data obtained from SeaWiFS sea spectral reflectance observations shortly after passage of Hurricane Mitch.

1DPA4.13
Atmospheric Controls on Sea Ice Motion in the Southern Beaufort Sea
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The Beaufort Gyre is characterized in winter months by an anticyclonic regime associated with Sea Level Pressure (SLP) highs. Previous studies have shown instances of a reversal in this regime in summer months with the arrival of SLP lows over the Beaufort Sea, while also demonstrating a link to variations in lower stratospheric potential vorticity. In this study we examine the role of relative vorticity in describing dynamic variability on weekly timescales from the surface to the middle stratosphere. Results from this analysis show that the Beaufort gyre is characterized predominantly by anticyclonic activity throughout the year for the time interval considered (from 1979 – 2000), with a summer reversal to cyclonic activity, whose strength and duration varies between years. These reversals coincide with reversals in SLP based on a correlation analysis. Comparison of ice and atmospheric relative vorticity fields in the Beaufort Sea region (BSR) for all weeks from 1979 – 2000 indicates that sea ice and lower tropospheric processes are anticorrelated at zero time lag. This is in contrast to relative vorticity fields at 10mb, which exhibit maximum correlation between stratospheric and sea ice responses when 10 mb leads ice relative vorticity by 2 – 6 weeks.

1DPA4.5
Microscale Atmospheric Predictability
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Due to the large memory requirement for running large ensembles, atmospheric predictability studies have not typically been performed using actual turbulence models. Instead, in the late 1960s and early 1970s, kinetic energy spectra of isotropic turbulence were calculated using

statistical models in order to make the first calculations of atmospheric predictability. These predictions include the 2-week forecasting limit. Since the 1990s, some studies at synoptic- and meso- scales have been performed using regional models and singular vector analysis, precluding the use of large ensembles once again.

With a simplified moist atmospheric turbulence model, we can perform microscale predictability studies using ensembles of initially nearly-identical runs. After a brief overview of the model we are using, I will present results of ensemble predictability simulations of a $(1\ km)^3$ atmospheric 'box'. As well, I will show how these results compare with historical findings for predictability on this scale.

3C1.1 **INVITED / INVITÉ**

Pseudo-global research from the Network for the Detection of Atmospheric Composition Change (NDACC/NDSC)

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Officially operational since 1991, and renamed recently as the Network for the Detection of Atmospheric Composition Change (NDACC) to better reflect its broader scope, the international Network for the Detection of Stratospheric Change (NDSC) was incepted and formalized during the late 1980s in response to the need to document and understand worldwide stratospheric perturbations resulting from increased anthropogenic emissions of long-lived halogenated source gases with strong ozone-depleting and global-warming potentials. The dual goal of long-term global measurement and understanding has led to the implementation of a ground-based network of globally distributed “primary” and “complementary” NDSC stations equipped with a suite of remote-sounding instruments, allowing the quasi-simultaneous study of a large number of chemical compounds, particles, and physical parameters. In the course of its 15 years of successful operation, the NDSC has contributed a unique atmospheric database and performed substantial research in:

- detecting trends in overall atmospheric composition and understanding their impacts on the stratosphere and troposphere,
- establishing links between climate change and atmospheric composition,
- calibrating and validating space-based measurements of the atmosphere,
- supporting process-focused scientific field campaigns, and
- testing and improving theoretical models of the atmosphere.

The object of this talk is to highlight some scientific achievements of the Network with a clear focus on pseudo-global studies based on the integrated use of data acquired at different sites.

3C4.5

Singular vector study of the excitation of Rossby-wave trains

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Singular vectors (SV) have been used at the Metorological Service of Canada (MSC) to analyze the influence of physical parametrizations (Zadra et al. 2004) and initial-time norms (Buehner and Zadra 2006) on the properties of unstable atmospheric disturbances in the Canadian Global Environmental Multiscale (GEM) model. There is evidence that Rossby wave-trains originating over the Western Pacific may significantly influence the middle- to long-range predictability of high impact weather over North America and beyond (e.g. Shapiro 2003). In this study, SVs will be used to study the excitation of these Rossby wave-trains by tropical and extra-tropical instabilites. Two types of cases are considered, where high-amplitude (and high-impact) Rossby

waves were observed (e.g. July-Aug 2002) and where they were predicted but not observed (i.e. false alarms). Singular vectors with appropriate norms and time scales are calculated to identify, at the time of excitation, mechanisms that control the Rossby wave amplitude. To better resolve the small-scale processes that potentially play an important role in Rossby wave-train excitation, the tangent linear and adjoint versions of the limited-area version of GEM (GEM-LAM) will be used in the future to compute the SVs at high resolution. Buehner, M. and A. Zadra, 2006: Impact of flow-dependent analysis-error covariance norms on extratropical singular vectors. To appear in Q. J. R. Meteor. Soc. Shapiro, M., 2003: A societal/economic impact perspective of Rossby wave-train propagation for the extreme northern-hemispheric weather events of November 2002. EGS - AGU - EUG Joint Assembly, Nice, France, 6 - 11 April 2003. Zadra, A., M. Buehner, S. Laroche and J.-F. Mahfouf, 2004: Impact of the GEM model simplified physics on extratropical singular vectors. Q. J. R. Meteor. Soc., *130*, 2541-2569.

4DPA6.2
Reactions of gaseous NO2 with hydrocarbon soot
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Nitrous acid (HONO) is an important photolytic source of OH and HO_2 radicals, which are involved in air pollution, in urban atmospheres at dawn when other radical sources are not working efficiently. Studies have shown that NO_2 can react with soot aerosols to form HONO in high yields. However, the rates of this chemistry as a function of relative humidity and substrate composition are not sufficiently understood to positively identify the primary source of these HONO levels. In this study a coated-wall flow tube coupled to a mass spectrometer was used to investigate the uptake of NO_2 on a variety of different soot substrates such as n-hexane, decane and benzene soot. The specific surface area of the soot films was determined by measuring the BET isotherm of Kr at 77 K. The results obtained as a function of temperature, NO_2 partial pressure, competing adsorbate gas partial pressure and relative humidity will be discussed.

4B4.4
Robust and non-robust atmospheric responses to global warming
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The robustness of the atmospheric response to global warming is investigated by performing a set of control and global warming experiments using atmospheric general circulation models (AGCMs). The global warming climate is simulated by prescribing the AGCMs with a SST perturbation that is independent of the model or model settings. We have investigated the robustness of the response as horizontal resolution, the strength of the (parameterised) gravity waves are varied, and when the dynamical core (bgrid versus finite volume) or the AGCM (GFDL's AM2 versus the CCCma model) is changed. We focus on NH winter.

The NH zonal wind response in all experiments is characterized by an upward shift and strengthening of the subtropical jet. The extratropical zonal wind response is very non-robust. It is also in this region that the zonal wind in the control run varies non-linearly as horizontal resolution or the strength of the gravity waves is varied. Some other meteorological fields also show that non-linear behaviour in the control run is a warning sign for non-robustness in the response to global warming.

The SH zonal wind response varies from experiment to experiment. However, the part of the response that does not project on the Southern Annular Mode (SAM) is robust, as opposed to the part of the response that does project on the SAM.

2C1.6

Chemical-dynamical coupling in data assimilation

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Many of the pressing questions about climate change and global air quality look at the development of an integrated atmospheric system of meteorological and chemical observations for analysis and forecasting. Although there are many known interactions between dynamics and chemistry in modelling, there is little done in terms in data assimilation. An example of this is the characterization of cross error covariances between meteorological variables such as temperature and chemical species such as ozone. A collaborative effort between the Meteorological Service of Canada, the Belgium Institute for Space Aeronomy, and York University is examining the linkages between dynamical and chemical variables in stratospheric data assimilation.

We will give an outline of the project and discuss several issues such as; the assimilation of RTTOVS in the stratosphere and if there is a need for bias correction, the monitoring of ENVISAT MIPAS and GOMOS meteorological and chemical observations, the issues of estimating error statistics for observed and unobserved chemical species, and cross error covariances between temperature and ozone, the application of the method of Desrosier for estimating error variances, and new ways for offline coupling in a data assimilation with analysis splitting.

3B3.7

Closing the oceanic heat budget

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The transport of heat by the ocean plays a major role in the global heat balance, and its variability is often thought to have important consequences for climate change. The traditional point of view is that in the ocean, the meridional transport of heat is achieved by the wind-driven and meridional overturning circulations. Furthermore, it is only in the Southern Ocean that eddies are believed to play a fundamental role in the heat balance. Here we examine the zonally-averaged oceanic heat budget. We argue that eddy-induced diapycnal fluxes are required to balance the surface heat input, a result that is not confined to the Southern Ocean, but applies throughout the global ocean. We further argue that eddy-induced mixing, especially in the surface mixed layer, can provide the so-called ``missing mixing'' required to close the oceanic heat budget.

1DPA2.6

Retrieving Forest Biochemical Parameters from Hyperspectral Remote Sensing Data

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Hyperspectral remote sensing provides spectrally continuous data for quantitative estimates of forest biochemical parameters. A geometrical optical model 4- Scale and a leaf-level optical model PROSPECT are combined to investigate the effects of canopy architecture on optical remote sensing signals. Using individual leaf reflectance and transmittance measurements, a set of canopy parameters, and viewing geometry (the solar and view zenith angles, and azimuth angles) as inputs to the 4- Scale model, the contribution of sunlit leaves and canopy-level reflectance are simulated. The simulated canopy reflectance is compared with the air-borne hyperspectral remote sensing data - Compact Airborne Spectrographic Imager (CASI). The comparison shows that the geometrical optical model can simulate the canopy reflectance accurately. Through 4-Scale modeling, a spectral multiple scattering factor is derived as a function of the leaf area index and solar zenith angle. By removing canopy geometrical and multiple scattering effects, the leaf-level reflectance spectrum is retrieved from canopy-level reflectance measurements. A look up table approach is developed for inversion from a canopy reflectance spectrum to a leaf reflectance spectrum for retrieving leaf chlorophyll content and other properties using the leaf-level inversion model.

Key words: Hyperspectral remote sensing Forest biochemical parameter Retrieval Model inversion

2C3.1 **INVITED / INVITÉ**

Nested Global Inversion for Carbon Budgets in North America with Biospheric Constraints

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Regional and global carbon budgets can be estimated through either biospheric modeling or atmospheric inverse modeling. Biospheric modeling reveals detailed spatial and temporal patterns of the carbon cycle, while inverse modeling so far has been meaningful for 22 regions of the globe (Transcom results). We seek a way to increase the number of regions in inverse modeling through introducing tight biospheric constraints to minimize the issue of relatively sparse atmospheric observations. A nested inverse modeling system is therefore developed for estimating carbon fluxes of 30 regions in North America (2 Transcom regions are divided into 30) and 20 regions for the rest of the globe. Synthesis Baysian inverse modeling is conducted in monthly steps using CO_2 concentration measurements at 95 coastal and continental sites of the globe for the 1994-2004 period (GlobalView database). Terrestrial carbon flux fields from biospheric modeling with and without remote sensing inputs (Biome-BGC and BEPS) are used as the *a priori* inputs to constrain the inversion. The inversion is completed so far for 2003, and the results show a spatial pattern in Canada in general agreement with a carbon source and sink distribution map previously derived through independent biospheric modeling (1 km resolution, InTEC model). However, apparent discrepancies exist in some regions in Canada, which were weakly constrained by existing atmospheric observations. Numerical experiments are being conducted with full covariance matrixes (i.e. non-zero diagonal values) of the *a priori* flux fields to achieve the full constraint using both atmospheric and biospheric data.

4DPA8.3

Tune in to river rhythms on your AM dial: amplitude modulation-based mathematical modelling of Englishman River temperature cycles

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Stream temperature is dominated by diurnal and annual cycles. These do not merely superimpose linearly. Rather, the amplitude of the diurnal cycle also evolves over the course of the year, being largest in summer and smallest in winter. Such dynamics are suggestive of an

amplitude modulation model, analogous to AM radio signals. Here, we develop such a model and apply it to two years of hourly mean water temperature data from the Englishman River on southeast Vancouver Island. The carrier wave consists of a sinusoidal diurnal cycle of constant (unit) amplitude. This is multiplied by an information signal, consisting of a periodic function with an annual timescale, and which thus forms an envelope within which the diel variations occur. The result is then linearly superimposed upon another periodic function with the same frequency and phase as the modulating signal. Best matches to the observations were obtained using squared sine functions for the annual cycles. The amplitude modulation model was found to capture the basic qualitative features of seasonal, and seasonally evolving diel, cycles. While it is only a heuristic approach which does not, in its present form, account for the effects of weather events and climatic fluctuations, the model nonetheless seems to offer a fresh perspective upon river temperature variability and may be of some practical utility.

3B4.1 **INVITED / INVITÉ**

Design of an ensemble prediction system for week 2 forecasts

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The range of the Canadian Ensemble Prediction System (EPS) has recently been extended from 10 to 16 days. This will permit the generation of products for the second forecast week. In the Canadian EPS, different combinations of state-of-the-art physical parameterizations are used for different ensemble members. Unfortunately, this multi-model strategy leads to rapidly developing biases in individual models. Consequently, a significant effort was required to reduce the bias in the individual models and thus permit the extension of the forecast-range with one week. As the forecast length increases, it becomes more difficult to validate potential improvements to the system using observations. The increasing spatial and temporal scales of forecast errors cause a reduction in the number of independent events that can be validated. The smaller skill scores also necessitate an increased length of the verification period. These factors will be illustrated using verifications of the recent improvements to the EPS. As the required length of the verification data set increases, the frequency of well-validated improvements to the system must decrease. The current multi-model strategy, which exploits a rich variety of imperfectly tuned model configurations, may have to be replaced by single-model strategy in combination with a stochastic description of "model-error". The latter combination could be tuned almost perfectly and any remaining bias could be well estimated using a long dataset of historical forecasts. However, the second moment would likely be deficient because the forecast uncertainty due to systematic weaknesses of the model would not sampled.

4C4.7

Climate Simulations over North America with the Canadian Regional Climate Model and ARPEGE-Climat.

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As part of a Quebec-France collaboration, the Climate Simulations team of the Consortium Ouranos is locally running the French global climate model ARPEGE-Climat. ARPEGE-Climat is a stretched grid model and the configuration used at Ouranos has the model pole near Winnipeg. The maximum resolution is 50 km in the center of the domain. Two 44-year simulations have been generated with ARPEGE-Climat, one for present-day climate (1958-2001) and one for future climate (2038-2081). Results from ARPEGE-Climat will be compared to simulations using the Canadian RCM (CRCM). CRCM is the standard model used by the Ouranos' Climate Simulations team for the generation of climate projections for Canada. The CRCM has a limited area grid covering North-America at 45 km. In this presentation, outputs from various versions of

CRCM driven by the coupled Canadian GCM (CGCM2). Both ARPEGE-Climat and CRCM will be compared to observations in current climate. Climate change signal from the two models will be also analysed.

3DPA1.4

ICTS: First results with the Canadian Regional Climate Model: Spin-up period evaluation.

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The Canadian Regional Climate Model (CRCM) maintained and operated by the Climate Simulations team of the Consortium Ouranos (MontrŽal, QuŽbec, Canada) is a participating model in the GEWEX Inter-CSE (Continental Scale Experiment) Transferability Study (ICTS). One goal of this project is to run different RCMs over different domains, each model having the same configuration everywhere, and to see how general is the application of a RCM over a climatic regime different from its homeland. For this purpose, 7 GEWEX domains were selected, two over north America (GAPP and MAGS), one over Europe (Baltex), one over Asia (GAME) one over south America (LBA/LPB), one over Australia (MDB) and one over Africa (Amma).
For this project, CRCM_V4.0.1 is driven by NCEP-DOE AMIP II Reanalysis and AMIP II SST and sea-ice for a 6-year period starting January 1999 to November 2004. North America region is the primary CRCM domain and many runs have been made over Europe, but the four others domains cover regions were the CRCM is used for the first time. Timestep is 15 minutes, resolution is about 45 km at the center of each domain and fields are archived every hour but for Europe (3 hours).
CRCM_V4.0.1 is using the Canadian LAnd Surface Scheme (CLASS_2.7). This 3-layer scheme requires a long spin-up to let the soil variables reached their equilibrium values. For our regular climate simulations, a 3-year spin-up period is used. However the ICTS runs are rather short and a spin-up of only a year is used for CRCM runs (while the ICTS criteria was 6 months). In this poster, the first analysis concentrates on the soil water content and spin-up behaviour in the different climate regions.

2B3.2

The effect of Siberian Wildfires on Carbon Cycling

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Wildfires are a dominant disturbance on the Russian landscape that historically burns 10-15 million ha annually (22 million ha in 2003). Unlike the high-intensity crown fires often experiences in North America, many of these fires are low- to moderate-intensity surface fires that do not kill the mature forests. The Russian FIRE BEAR (Fire Effects in the Boreal Eurasia Region) Project is

an international collaborative study designed to address problems in central Siberia associated with the management of fuels, fire, and fire regimes for enhancing carbon storage and forest sustainability with the aim of minimizing the negative impacts of fire on global environment, wood production, and ecosystem health. Quantitative measurements on experimental fires conducted in Scots pine (*Pinus sylvestris*) forests in central Siberia show that surface fires emit 4.8 to 15.8 t C ha^{-1} depending upon burning conditions, mainly as a result of organic forest floor consumption. Fire is generally considered to be a source of carbon for forest accounting under the Kyoto Accord. Our emission sampling has documented the major carbon-based gases produced by these fires. However, while fire initially releases carbon, we have observed marked decreases in post-fire soil respiration following fire with the greatest decreases being on the most severely burned sites. These decreases are large enough that they may counter some of the direct fire-related carbon emissions. Increased wildfire activity, which has been predicted in response to a 2 x CO_2 climate change scenario, has the potential to significantly affect the carbon storage of future Siberian forests.

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1DPA1.18

Development of an extrapolation component for a nowcasting module.

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The Canadian Meteorological Centre is developing a module to extrapolate clouds and precipitation types. The system starts by extracting surface observations over Canada, northern U.S. and western Greenland. These observations are transformed into analyses using a kriging technique. Although only cloud and precipitation type analyses will be extrapolated, analyses for several other surface parameters are produced, including temperature (dry and dew-point), winds, pressure, convection, etc. A rule-based consistency module uses those parameters to produce consistent analyses. As an example, no freezing precipitation will be analyzed with above-freezing temperatures. These analyses are then blended with NWP data from our regional

model over adjacent waters, were there are no surface observations. The blending module will also incorporate data from radars, satellites and lightning detectors to produce the best possible analyses at initial time. These analyses will then be interpolated on a higher resolution grid (7 km). Nowcasts will be obtained by extrapolating these final analyses using the wind field at 1 hour intervals from the NWP model. Values from these extrapolated fields are interpolated at the stations. These values can be used in two different ways: as a direct nowcast technique or as predictors for a statistical technique. We plan on testing both approaches. A prototype version of the extrapolation module has been developed and preliminary results will be shown.

2DPA6.17
Stratospheric transport trends in an ensemble of transient CMAM simulations from 1960 to 2050.
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The Canadian Middle Atmosphere Model (CMAM) is a 3D chemistry-climate model with 71 vertical levels extending to about 100 km and a T31 horizontal resolution. It includes a heterogeneous chemistry scheme with parameterizations for STS and ice polar stratospheric clouds. CMAM has been used to perform three 100 year simulations of the atmosphere encompassing the period from 1960 to 2050, driven by evolving sea surface temperature (SST) and atmospheric inputs of key chemical constituents (carbon dioxide, methane and CFCs). Previous CMAM timeslice simulations indicated that increased carbon dioxide levels and associated SST changes lead to an intensification of the Brewer-Dobson circulation and tropical upwelling in particular. For this presentation our focus is on the trend in tropical upwelling and its effect on the water vapour distribution in the lower polar stratosphere which is important for ozone loss. We find a gradual decline in the age of air in the tropics and middle latitudes and increased water vapour concentrations at high latitudes.

4DPA6.7
Determination of Volatile and Semivolatile Organic Compounds in Snow Samples from Urban and Rural Quebec
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Snow samples were collected in three different areas in Quebec: Downtown Montreal, Mont Saint Hilaire (45 km East of Montreal) and Parc Tremblant (140 km North of Montreal), representing urban and (semi-)rural areas. Except for downtown Montreal, at least 3 locations were sampled in each area, taking a minimum of 5 surface snow samples (0-10 cm) in amber glass bottles and sterile HDPE containers. Blank samples consisting of ultra-pure water were collected by opening and filling open containers on site to ensure identical treatment with snow samples.

Samples were collected using standardized cleaning and sampling procedures to ensure comparability. VOCs were determined by solid phase micro-extraction (SPME) of the headspace and liquid phases and subsequent analysis with gas chromatography and mass spectrometric detection for identification and quantification. Twelve organic compounds were quantified in the liquid phase by external calibration with aqueous standard solutions.

Splitless injection mode was used after careful removal of water drops from the fiber holder and LODs were in the range of 0.003 µg/l (for m- & p-xylene). Results showed a wide range of detected compounds including alkyl-substituted benzenes (e.g. ethylbenzene), aldehydes (e.g. nonanal), halocarbons (e.g. chlorobenzene) and ketones (e.g. acetophenone) with 20+ identified

compounds per sample. Concentrations of quantified VOC varied in low µg/L range, between 0.010 µg/l for o-xylene and 1.217 µg/l for benzene. The potential implications of these results for the underlying atmospheric processes will be discussed.

1B4.8

Surface temperature lapse rates over an Arctic Icefield: Implications for temperature downscaling and for modelling of icefield response to climate change

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Models of glacier and ice sheet dynamics require estimation of surface mass balance: the net annual accumulation vs. ablation of snow and ice. Meteorological observations from glaciers and ice sheets are exceptionally rare, so estimates of snow and ice melt are typically based on extrapolations from distant, low-altitude weather stations or interpolations from modelled or reanalyzed climatology. Either way, temperature lapse rates must be assumed to estimate the temperature in the near-surface environment (screen temperature), which is known to drive snow and ice melt. These lapse rates differ from free-air values, as they are governed by energy balance at the surface-atmosphere interface, rather than free-air processes. I present field measurements from the Prince of Wales (POW) Icefield, Ellesmere Island, Nunavut, which indicate that near-surface temperature lapse rates are much less than typical free-air rates: typically –3 to –5°C km^{-1}, with strong seasonal and synoptic variability. Observations on the POW Icefield indicate that models of icefield mass balance based on meteorological data from the nearest Environment Canada observation stations – Eureka and Grise Fiord – would dramatically misrepresent the actual mass balance of the Icefield. However, a combination of station data and regional upper-air flow indices offers promise for lapse rate and temperature prediction. I present initial analyses of how the regional circulation conditions influence the surface energy balance to create this relationship.

2DPA6.11

Simulating the Evolution of Stratospheric Ozone depletion: Growth of a problem

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The CMAM model, a middle atmosphere GCM with interactive chemistry, has recently been used to create a ensemble of transient climate simulations for the period 1950 to 2050. The simulations are part of the ongoing WMO assessment of the ability of current AGCM's to model the past and possible future evolution of stratospheric ozone depletion. The experiments involve time varying surface inputs of various chemical fields (including methane, CO2, nitrous oxide and CFCs) as well as time varying SST's which allows the study of the combined influences of these changes upon the stratosphere and hence on the evolution of the ozone field. This paper will concentrate on the analysis of the development of the Antarctic ozone hole as simulated from the 1970's through to current day. Overviewing the simulation of the ozone hole's development from the past through to a possible future realization, highlighting the changing nature of the SH springtime Vortex growth, development and its role on determining the extent of ozone loss.

4B3.4

Observations and Modeling of Air-Sea Gas Exchange in the NE Pacific

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A fundamental constraint on the accuracy of coupled air-sea climate models is the state of our knowledge of the coupling process. The atmosphere-ocean coupling algorithm, which is critical to the correct specification of air-sea fluxes, must be representative of the air-sea feedback processes. The availability of new instrumentation for *in situ* measurements of upper ocean bubbles, dissolved CO_2, O_2 and N_2, allow for the calculation of dissolved oxygen budgets which are linked in turn to net production and the CO_2 budget, thus closing a loop in upper ocean gas exchange.

As part of the Canadian SOLAS study an air-sea exchange mooring equipped with an array of sensors to measure temperature, bubbles, gases, fluorescence and advection rates in the upper ocean boundary layer has been deployed continuously at Ocean Station Papa (50N, 145W) since the fall of 2002. Here we present the available dataset and discuss some of the scientific implications on upper ocean gas cycling from the data analysis and model simulations.

1C3.6
Turbulent self-diffusion in isopycnal coordinates
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A recent paper by Dukowicz and Smith (1997), henceforth referred to as DS97, extends the classical theory of turbulent transport of a tracer particle (Morin and Yaglom, 1987) to encompass the problem of self-diffusion in stratified mesoscale oceanic turbulence, thereby shedding light into the mathematical status and physical meaning of the recent parametrization of Gent and McWilliams (1990). This is interesting and important in view of the fact that the theory of geostrophic turbulence is still in its infancy.

The stated objective of DS97 is to develop the stochastic theory of turbulent diffusion from the standard Fokker-Planck equation (Morin and Yaglom, 1987; Gardiner, 2004) in such a way that it also applies to compressible flow. The reason why this is deemed necessary is that when the classical, incompressible Boussinesq equations are expressed in isopycnal coordinates the velocity field ceases to be solenoidal. We will show that the argument presented in DS97 is incorrect, although their main result can, fortunately, be salvaged.

3C1.3
Intercomparison of Ground-Based Zenith-Sky DOAS Measurements of Ozone and NO2: Results From the SAOZ and UT-GBS Instruments
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In 1998, a portable zenith-sky-viewing UV-visible diffraction grating spectrometer was assembled at the University of Toronto (the University of Toronto Ground-Based Spectrometer, UT-GBS). Since then it has participated in eight field campaigns in the Canadian High Arctic: seven times in Eureka, Nunavut (80N, 86W, 1999-2001, 2003-2006), and once in Resolute Bay, Nunavut (75N, 95W, 2002). It has also taken part in all four MANTRA (Middle Atmosphere Nitrogen TRend Assessment) balloon campaigns held biennially in Vanscoy, Saskatchewan (52N, 107W, 1998-2004). Total vertical column density amounts of ozone and NO2 are regularly retrieved, while slant column densities of BrO and OClO are retrieved when possible.

This presentation will discuss measurements from the MANTRA 2004 campaign and the Eureka 2005 and 2006 campaigns. A SAOZ (Système d'Analyse par Observations Zénitales) spectrometer was part of the instrument suite of these campaigns, allowing for the first side-by-side measurements of the two instruments. Identical analysis methods have been applied to both SAOZ and UT-GBS spectra.

During a large portion of the Eureka 2005 campaign, Eureka was located near the edge of the polar vortex, with afternoon measurements sampling air masses located outside the vortex, and morning measurements sampling air masses located both inside and outside the vortex. This has made for some interesting and challenging analyses, which will also be discussed.

1DPA4.9
An available energy of middle atmosphere circulation including momentum constraints
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A theory of available energy for the zonally averaged meridional circulation in the middle atmosphere is presented, including momentum constraints. The theory is based on the Hamiltonian structure of the underlying conservative dynamics, but includes the effect of forcing and dissipation. Dynamical (angular momentum) constraints prove to be important in diagnosing mechanically driven, thermally damped meridional circulations, as is the case in the middle atmosphere. Applications of the theory in the context of the middle atmosphere circulation are discussed.

2C4.2
A Seasonally Lagged Signal of the North Atlantic Oscillation (NAO) in the North Pacific
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The North Atlantic Oscillation (NAO) has been identified as an important mode of variability in the climate system. However, little is known about its impacts on the climate of the North Pacific region. In this paper, we discuss the existence of a seasonally lagged signal of the NAO in the North Pacific region. In particular, we show that the spring sea-level pressures and surface temperatures in the region are positively correlated with the characteristics of the NAO during the preceding winter. This signal is identified in a number of long-term climate datasets including a Japanese tree ring time series that has been shown to be a proxy for spring temperatures in the North Pacific region. We identify two distinct mechanisms responsible for this lagged signal: one involving sea surface temperature anomalies in the North Pacific and the other involving Eurasian snow anomalies. We show that both of these anomalies develop during the winter and persist into the spring resulting in the observed lagged response.

1C4.5
Sea-ice deformations: observations and modelling results
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Satellite observations of Polar regions now allow us to validate many aspects of dynamic/thermodynamic sea-ice models. Derived deformations from high resolution satellite measurements reveal that on a large scale the Arctic sea-ice cover is mainly characterized by regions of low deformations; only very narrow regions exhibit large deformations (shear and divergence). However, these narrow regions (leads) are crucial for heat exchange between the ocean and the atmosphere. A sea-ice model used for climate simulations therefore has to

properly represent the statistics of lead formation. We here compare the deformations derived from RADARSAT satellite data to the deformations simulated by the dynamic/thermodynamic model developed by Tremblay and Mysak. We focus on the representation of the rheology and we try to answer the following question: can a viscous-plastic sea-ice model simulate adequately these deformations?

1DPA3.6
Which wind forcing fields should be used for the Little Ice Age?
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The goal of this model study is to investigate the relationship between the Arctic sea-ice cover and the ocean circulation during the Little Ice Age. The model used in this investigation is the UVic Earth System Climate Model coupled with the granular sea-ice model of Tremblay and Mysak. Due to the use of an energy moisture balance model for the representation of the atmosphere, the wind stress has to be prescribed. Since there are no observed wind fields during the Little Ice Age (1500-1850), the question arises as to what methodology will be used to obtain these wind fields. Three different approaches to obtain these wind fields are proposed: i) the climatological approach, ii) the analog index approach, and iii) the decomposition approach. Results for the ice-ocean variability using the latter two approaches will be presented in this talk.

1DPA3.7
A Newly Developed Triple-Moment Blowing Snow Model
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We describe how to extend a double-moment blowing snow model to triple-moment model. From observation and theoretical analysis, we know blowing snow particles follow three-parameter gamma size distribution. The size distribution will be narrower and more symmetric with height and time due to sublimation effects. In the existed double-moment model, blowing snow mixing ratio and number concentration, the third and zero moment of the distribution, are predicted by equations including diffusion, sedimentation and sublimation terms. The shape parameter of gamma distribution is set to constant in double-moment model, which cannot indicate the narrowing of particle size distribution. In order to release the limitation of , the sixth moment of size distribution (radar reflectivity) is introduced to the model and the corresponding predictive equation is derived. With these three moment equations, the three-parameter size distribution can be predicted. In the ideal case, the triple-moment model has the same ability to predict the profiles of number concentration, mixing ratio as those of the double-moment model. Besides it can give the exact evolution of particle size distribution as spectral models. The triple-moment model is then applied to three real cases. The results indicate that the model is validated in predicting the size distribution of particles as well as the profiles of number concentration and mixing ratio. The superiority of triple-moment model over double-moment model is evident comparing the results predicted by both models with observations.

4B3.7
DMS cycling in the NE Pacific versus NW Atlantic: Does Fe matter?
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Ocean production of dimethylsulfide (DMS) contributes to climate regulation via the formation of aerosols that scatter solar radiations and increase the albedo of clouds. DMS emissions thus alter the radiative balance of the Earth and can potentially exert a cooling effect on climate. DMS is produced from the degradation of its algal precursor dimethylsulfoniopropionate (DMSP). Few microalgae have the capability to directly produce DMS, but most of DMSP degradation is believed to occur indirectly, through the release of algal DMSP and its subsequent uptake by bacteria. To assemble global-scale data on DMS(P) stocks and biological cycling rates, a comprehensive study was conducted in the Northeast Pacific and Northwest Atlantic oceans as part of the Canadian SOLAS program. DMSP standing stocks and DMS biological gross production rates were consistently higher in the NE Pacific than in the NW Atlantic. Key control processes of DMS cycling were investigated in relation to the prevailing environmental characteristics (e.g. mixed layer depth), limiting nutrient (Fe *versus* N limitation), and food web characteristics.

2DPA6.18

Evaluation of Chemical Ozone Loss in the Polar Lower Stratosphere in the Whole Atmosphere Community Climate Model (WACCM3)

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Chemical ozone loss from three secular 54-year WACCM simulations (1950-2003) is analyzed using tracer-tracer correlations. Meteorological fields, such as the temperature distribution within the polar vortex, lifetime and strength of the vortex are compared with available UKMO meteorological analyses between 1992-2005 and ERA40 reanalyses between 1960 and 2005. The entire Antarctic vortex is slightly warmer during the winter between 400-600 K potential temperature, whereas the vortex core is colder between August and October. The Antarctic polar vortex is rather strong compared to meteorological analysis and has a longer lifetime. The PSC formation potential, based on the temperatures, the volume and lifetime of the polar vortex, is approximately one third less in the Antarctic compared to meteorological analysis for the entire vortex between 1960 and 2005. Nevertheless, in the nineties and 2000's, observed accumulated ozone loss is reproduced in the WACCM3 simulation at the end of the winter within the vortex core, due to colder temperatures in that area. The evolution of chemical ozone loss of a specific Antarctic winter of one WACCM3 simulation compared with ILAS-II satellite observation indicates a similar evolution of chemical ozone destruction. WACCM3 accumulated chemical ozone loss increases between 1960 and 1990 as expected, owing to the increasing of chlorine content in the stratosphere. The Arctic vortex in WACCM3 is more than 5 degrees warmer than observations between November and February and shows temperatures similar to meteorological analysis during March. The temperatures within the vortex core are comparable to meteorological analyses. However, the entire volume of the vortex and the cold vortex core is significantly smaller in the WACCM3 simulation. For the entire simulation a major warming occurs not later than in early April. For Arctic winters, warmer temperatures in WACCM3 result in much smaller chemical ozone loss in comparison to observations. For the Antarctic, the relation between accumulated chemical ozone loss and PSC formation potential of the WACCM3 simulation indicates that the chemistry of the WACCM model is able to reproduce realistic chemical ozone loss. However, observed accumulated chemical ozone loss values are not reached, because of biases in the meteorological fields in both Arctic and Antarctic.

4DPA6.18

Analysis of ambient cloud condensation nuclei concentrations in a semi-rural setting

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Given the importance of cloud condensation nuclei (CCN) to levels of incoming solar radiation and climate in general, it is essential that the aerosol-to-droplet nucleation process be well understood. A major uncertainty in this regard is the role of the aerosol organic component in promoting cloud droplet activation. In this study, we test our current understanding of aerosol activation by comparing measured ambient concentrations of CCN with concentrations calculated using Kohler theory. Sampling occurred in the fall of 2005 in a semi-rural setting 70 km north of Toronto which was influenced by clean air and by air from the more heavily populated south. Instruments used during the study included an aerosol mass spectrometer (AMS), an ultrafine condensation particle counter, a scanning mobility particle sizer, an aerodynamic particle sizer, and a thermal gradient diffusion CCN chamber. In particular, the AMS yields aerosol size-dependent composition information. Results build on our first study that was conducted on a busy street in downtown Toronto and are part of our ongoing efforts to examine the role of organic compounds in aerosol activation.

3DPA5.7

Seasonal Evolution of the Circulation in the North Water Polynya, Baffin Bay

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In 1997, an international field program was conducted in the North Water (NOW) polynya, in Northern Baffin Bay, Canada. For three consecutive years, this polynya was sampled by a large community of scientists concerned about impacts of global changes on this fragile ecosystem. Our study present an estimation of the baroclinic and barotropic currents obtained from a combination of the dynamical method with the Wunsch inverse approach. Those horizontal currents are subsequently used in a 3D box model as to generate the monthly circulation pattern for April, May, June 1998 and September 1999.

1DPA4.15

Numerical Study of a Tornado-Like Vortex in a Supercell Storm

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Tornadogenesis is studied by using a three-dimensional munerical simulation of a tornadic supercell storm. This is carried out by using the Canadian Mesoscale Compressible Community model (MC2).

The simulation is initialized with a thermodynamic profile similar to the one used by Weisman and Klemp (1982,1984) and a vertical profile of horizontal wind as the one used by Wicker and Wilhelmson (1995).

We were able to reproduce the main features of the conceptual models of tornadic supercell storms, such as forward flank downdraft (FFD) , rear flank downdraft (RFD) and a hook shaped reflectivity region surrounding a cyclonic rotating updraft (hook echo region). A tornado like vortex is developed in the tip of this hook echo region, within the vertical velocity gradient between the updraft and RFD. The analysis of the vorticity isosurfaces and the backward trajectories analysis suggest that the tilting of horizontal vorticity into the vertical and further stretching as the main mechanisms in the production of a tornado like vortex.

4C1.7

Processing of mineral dust aerosol with gaseous nitric acid

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Mineral dust can affect gas phase chemistry in the troposphere by providing reactive sites for heterogeneous reactions. In the experimental laboratory studies presented here the HNO3 uptake by airborne mineral dust particles was investigated.
The kinetics of the heterogeneous reactions was investigated in the flow tube reactor by online measurement of particulate and gas-phase reaction products. Most experiments were carried out using the radioactive tracer technique, where HNO3 was labeled with the isotope 13N which was produced at the Paul Scherrer Institute, Switzerland. The products of heterogeneous reaction (i.e., HNO3, HONO, NO2) were separated in a parallel-plate denuder train coupled with an online gamma-spectroscopy detection. The experiments were performed at temperature and pressure conditions typical to real troposphere (T 298K, p ~1atm, RH 6-60%).
The uptake of nitric acid from gas phase was found to depend on HNO3 and H2O concentrations in the gas phase. Experiments showed that the uptake coefficient increased several times by increasing the RH in the flow reactor. The results of kinetic simulations suggest that the reaction is promoted at higher RH as a number of the reactive sites on mineral dust surfaces increases with increasing relative humidity. A reaction mechanism is suggested to describe the heterogeneous interaction, involving gas-surface diffusive transport, Langmuir type adsorption and surface reaction. The number of important kinetic parameters is derived which should be used in atmospheric chemistry models to improve the reliability representation of the effects of relative humidity on dust aging.

2DPA6.15

Dynamical Balances for Data Assimilation

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In atmospheric data assimilation physically-meaningful balance relations are imposed in order to constrain the analysis variables and thus mitigate the impact of uncertainty in forecasts and observations. The derivation and effective application of such approximations is currently an area of active research. Using the Canadian Middle Atmosphere Model as a proxy for the real atmosphere, we compare the degree of balance present in the troposphere and the middle atmosphere, for a number of balance schemes involving the wind and mass fields. It is found that nonlinear balances perform significantly better than linear ones, however very little balance is found in the tropics and the mesosphere. We present theoretical approaches appropriate for balance at low latitudes, which take into account the anisotropic nature of large-scale tropical flow as well as an important mode of variability known as the equatorial Kelvin wave. However, it appears that in the tropics, gravity wave modes often obscure the underlying balance. Some assimilation centres have reported improvement in analysed fields after implementing the quasigeostrophic omega equation as a constraint on the vertical motion. We report on similar experiments with a 3D-Var assimilation scheme developed at Environment Canada.

2B1.2 **INVITED / INVITÉ**

An Overview of Chemistry and Transport in the Tropical Tropopause Layer

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It now common to view the boundary between the tropical troposphere and stratosphere as a layer rather than a discrete interface. This talk will review the conceptual advantages of this approach, especially with respect to the transport of tropical tropospheric air into the stratosphere, and the mechanisms whereby tropospheric air is dehydrated in the TTL. These processes play an important role in determining the chemical composition of the stratosphere, and subsequently affect ozone chemistry in the stratosphere, and climate in the troposphere. I will emphasize the importance of the convective detrainment profile in the TTL, and discuss various indirect chemical and thermodynamic constraints on its shape.

2DPA6.1

Planetary wave reflection and the QBO

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We investigate how the QBO phase couples with the planetary wave transmission properties and polar vortex variability of the northern hemisphere winter stratosphere. Both atmospheric GCM model results from the Canadian Middle Atmosphere Model (CMAM) and reanalysis data (ERA-40 and NCEP-NCAR) are employed to look for evidence of a Holton-Tan effect expressed through the reflection of upward-propagating planetary waves. This reflection is expected to be more likely when the polar vortex is stronger. Model results, consisting of runs both with and without a QBO, allow us to compare the effect that the inclusion of a QBO has on the model's extratropical variability and mean state. A more realistic polar vortex results when the model exhibits a QBO.

3B4.2

Models of International Cooperation: The North American Ensemble Forecast System (NAEFS) and the THORPEX Interactive Grand Global Ensemble (TIGGE)

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The benefits of considering different possible solutions to the weather forecast problems of the day have long been known to forecasters. In Canada, it is common practice to look at the GEM regional and global models, along with one or more American models during forecast preparation. It is becoming common practice also to look at forecasts from an ensemble system, especially for medium range forecasts. Well, what if we could put together, in real time, two or more ensemble systems, to be used either in combination with operational deterministic models, or alone as a combined ensemble?

This is the goal of NAEFS: To exchange and combine the Canadian and American ensembles in real time, and to produce probabilistic forecasts from the combined ensemble which are consistent over all of North America. The NAEFS project formally began in November, 2004, and the first implementation is planned for May 2006. Further implementations of expanded sets of forecast products are expected in March 2007 and 2008.

While NAEFS is focused on the development and implementation of joint real-time forecast products, TIGGE is a research project intended to determine whether the combination of ensembles in multi-model, multi-analysis configurations provides benefits in the form of improved

estimates of forecast uncertainty. TIGGE is more ambitious than NAEFS, since it brings together the 9 centers worldwide who routinely prepare global ensemble forecast products. TIGGE also has a technological component: to determine the feasibility of exchanging and managing the enormous datasets that are created daily by some 350 ensemble members, each forecasting more than 50 variables, each 12h to at least 10 days.

The presentation will summarize the plans and progress to date in both NAEFS and TIGGE.

4DPA6.5
Laboratory Studies of Ice Formation via Deposition Mode Nucleation onto Dust Samples
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Laboratory studies are described whereby the heterogeneous ice nucleating ability of various dust samples was studied for particles mounted on a hydrophobic support. Ice formation is observed using digital photography and the relative humidity (RH) and temperature conditions of the flow system are validated by observing $(NH_4)_2SO_4$ deliquescence. Four types of dust samples, including authentic Saharan dust, alumina, silica and montmorillonite, were investigated in the vapor deposition freezing mode. The size of the dust particles ranged from 1 to 5 microns, and the temperature range was from 263 to 218 K. In addition we also present in the same temperature range, ice nucleation onto dust surrogate in particular Arizona Test Dust, and anthropogenic metal particles including aluminum, titanium, and zinc. With roughly 10^4 particles present on the cold stage, the onset for ice formation was observed at low relative humidities, between 102 and 108 % RH_i, for the dust samples at all temperatures. This indicates that deposition mode nucleation is an efficient mode of ice formation, particularly under the cold temperatures prevalent in the cirrus regime.

1DPA2.7
Intercomparison of simultaneously-obtained infrared and visible spectra of ozone and nitrogen dioxide using ACE-FTS and MAESTRO
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Laboratory gas absorption spectra were measured in the visible and infrared spectral regions using SCISAT-1's MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) and ACE-FTS (Atmospheric Chemistry Experiment – Fourier Transform Spectrometer) spectrometers, respectively. These measurements were obtained by using a specially-designed solar simulator source which supplies stable, high-intensity illumination across a very wide spectral region. Spectra resulting from the absorption of solar simulator light by ozone and nitrogen dioxide in a gas cell were recorded by the two instruments simultaneously. An intercomparison of these measurements was used to assess the relative accuracy of the HITRAN ozone infrared band strengths, for which there was a 4 % change between the 2000 and 2004 versions. Results reported here show that Chappuis band cross section strengths are more consistent with the HITRAN 2004 4.8 µm band line strengths than with the 2000 compilation. A similar intercomparison of the nitrogen dioxide 3.4 µm band line strengths with the visible cross-sections indicate a very good agreement between the Vandaele et al. (2002) temperature-corrected cross-sections and the HITRAN 2004 infrared line strengths.

2DPA5.7

The Transcom Forward Modelling Project: GEM-AQ results

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The Transcom forward modelling experiment is a model intercomparison study to assess the consistency of transport models in simulating carbon dioxide concentrations on "short" time scales. ÊGEM-AQ, based on the Canadian weather forecast model GEM, is an on-line air quality model developed by MAQNet1 in collaboration with MSC and funded by CFCAS, is participating in this forward modelling experiment. The TRANSCOM experiment consists of a four-year model run tracking seven carbon dioxide tracers emitted at several temporal scales. ÊThe emission files for each tracer were prepared by Transcom using the simple biosphere model (SiB), the CASA biosphere model, the Takahashi ocean flux data set and a 1998 data set for industrial CO2 emissions. A comparison of the CASA and SiB model results are used to determine the value of coupling a biophysical process model with GEM-AQ. Use of the tracers with different averaging time scales (hourly, daily and monthly) will yield information on the importance of diurnal simulation of CO2 fluxes, the effects of the PBL and possibly large scale convection. Model results from the transport study will presented.

1DPA1.8

Numerical Simulation of the Inner Core Structure of Hurricane Isabelle (2003)with a High Resolution Nonhydrostatic Model

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Hurricane Isabelle was a classic Cape Verde hurricane formed from a tropical wave that moved westward from the coast of Africa on 1 September 2003. It strengthened to a Category 5 hurricane on 11 September with maximum sustained winds estimated at 74 m/s at 1800 UTC. After this peak, the maximum winds remained in the 65-70 m/s range and the storm maintained a major hurricane status, with a notable large eye (60-80 km diameter) and eyewall. This study aims to understand the evolution of the inner core vorticity, and eyewall replacement, as well as their effects on the structure and intensity of the hurricane. A high-resolution model (MM5) simulation of Isabelle is performed and satellite data are used to validate the model results.

The track and intensification of Isabelle from September 7 to September 13 were simulated with a 3-domains (54km x 18km x 6km) and two way nested configuration of MM5. NCEP reanalysis data were used to generate the initial fields and lateral boundary conditions. In addition to the standard meteorological initial and boundary conditions, a bogus vortex was inserted in the initial fields on 00 UTC September 7 using the vortex relocation technique of Liu et al. (1997).
The results showed that, relative to the best track analysis, the simulation reproduces the storm track and intensity very well.

The coarse resolution (6km) simulation cannot resolve the fine structures. However, when nested to a resolution of 0.67 km, many features depicted in high resolution satellite picture of Isabelle were reproduced. They include the smaller vortex in the eyewall of the hurricane and the polygonal structure of the eyewall. Research on understanding these fine scale structures is in progress.

3B4.4 **INVITED / INVITÉ**

Objectives of the THORPEX working group on data assimilation and observing strategies for high impact weather forecast improvements

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One of the THORPEX working group is concerned with *Data assimilation and observing strategies* that would lead to improvements of high impact weather. Targeting techniques have been used to deploy adaptive observations over sensitive regions where small changes to the analysis have the potential to significantly improve the forecasts. Two conclusions stood out from the impact studies that were recently performed with the targeted data collected during the 2003 Atlantic THORPEX Regional Campaign (ATReC 2003): given their small number, they had very little impact globally but each observation has individually more impact when taken over a sensitive region. When it comes to satellite data, only a small fraction of the data received can be assimilated due to limitations in the assimilation process. The same information used for targeting can be used to better select existing data so that they provide key information for the development of high impact weather. Progress is also needed in the assimilation of satellite measurements in cloudy and/or rainy conditions.

Forecasts in the 1 to 14 day range require a global approach: what goes on in the Tropics can often influence a forecast over Canada. However, when it comes to precipitation or high winds weather events, high resolution models are needed. These can benefit from simply downscaling the global analyses but it is important to know what other high resolution elements should be present in the analysis for those models. As the end product of the forecast is related to socio-economic aspects, collaboration with the socio-economic and predictability working groups is needed. THORPEX provides the framework for international collaboration to address the end-to-end forecasting problem for high impact weather from the collection of observations to the socio-economic applications.

2C1.4
Ozone-tracer relations as a tool for deducing chemical polar ozone loss from measurements and model results

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Investigating ozone tracer relations (TRAC) has been established as a reliable tool for polar ozone loss; the technique has in the past been applied mostly to data obtained from observations. Mixing across the vortex edge will impact ozone tracer relations even in the absence of chemical change. This process is particularly relevant for the application of the TRAC technique to model results, where the transport barrier at the vortex edge is often not well reproduced. In this paper, we discuss the impact of mixing across the vortex edge on the chemical ozone loss as deduced with TRAC. Applications to both measurements and results from models will be shown. We will demonstrate that with TRAC, if applied with care, reliable estimates for polar chemical ozone loss can be derived from both measurements and model results. We will present applications of TRAC to model results from the DLR chemical climate model E39C.

3DPA3.7
Comparison of weather forecasts to weather station data for Waterloo, Ontario between 2001 and 2005

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A variety of weather forecasts are currently available for most regions of Canada, however there is often a marked difference in these forecasts. This causes confusion with the public when the

forecasts don't agree and leads to a general distrust of all forecasts. This goal of this project was to access the accuracy of each individual forecast and to demonstrate the value of having multiple forecasts for a region.

For this study, data from the University of Waterloo weather station were compared to the forecast for Waterloo obtained daily from Environment Canada and The Weather Network covering a period from 2001 to 2005. In addition, the weather station data were also compared to forecasts based upon climatology and persistence.

The University of Waterloo weather station (weather.uwaterloo.ca) has been in operation since 1998 providing detailed weather information for researchers and the general public. Current conditions as presented on a website on a webpage that is updated every 15 minutes as well as a publicly available archive of past weather conditions.

Comparisons were made for both temperature and precipitation for forecasts periods up to 5 days in the future. The results are presented showing the accuracy of each forecast compared to the weather station data.

The next phase of the study will be to compare the measured data to a greater number of forecasts and examine the accuracy of ensemble forecasts.

3B1.5

Observations of Winter Precipitation with a Dual Polarized C-band Radar

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In 2005, Environment Canada (EC) began operating a new C-band dual polarization scanning Doppler radar at King City, Ontario, just north of Toronto. This paper describes observations of precipitation in south central Ontario during the winter of 2005/06, its first full winter of operations. The focus is on the ability of the radar to deduce the nature of the precipitation. Helping with the verification of the precipitation type was a suite of specialized surface precipitation sensors that was deployed to the EC Centre for Atmospheric Research Experiments 30 km north of the radar. This included the X-band vertically pointing radar (VertiX) and a hydrometeor velocity and size detector (HVSD), both provided by McGill University.

A number of cases have shown the ability of the radar data to distinguish the boundary between rain and snow. The correlation coefficient parameter was been shown to be the best indictor of this. Also, the radar could distinguish different snowfall characteristics that is indicative of different modes of growth, modes that to some extent were affected by the presence of the open waters of the Great Lakes. The differential reflectivity was the key parameter in these cases.

Challenges to the processing of the data to take into account at one extreme low signal to noise ratios in snowfall and at the other extreme attenuation in precipitation transition regions are highlighted. The potential for enhanced interpretation of the dual polarization radar measurements in winter storms with the development of automated precipitation type algorithms is discussed.

4DPA7.1

Diapycnal mixing at the thermocline: estimates from the C-SOLAS NE Pacific mooring.

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Atmosphere-Ocean gas exchanges are modulated through a thin (O(100m)) oceanic boundary layer (OBL), commonly referred to as the surface mixed layer (ML). Numerous small-scale processes directly influence the water characteristics within this layer, most of which cannot be resolved in current climate numerical models. One particular area that has a dearth of information is the tens of meters below the ML, which harbors steep temperature and density gradients. The effects of physical processes at the thermocline depth, notably gaseous exchange with deeper layers, play an important role for the geochemical cycle of carbon and yet are poorly understood.

The Canadian SOLAS Northeast Pacific mooring at Ocean Station Papa (OSP) (50°N 145°W) active from September 2002 to June 2006 was specifically designed to study air-sea exchange in the OBL for an oceanic region subject to high wind inputs and seasonal cycles of vertical stratification. Since June 2004 the addition of an acoustic Doppler current profiler to the mooring instrument line-up allowed measurements of current shear at the thermocline. Using the former data combined with density estimates compiled from Argo floats, we derived estimates of dissipation below the ML at OSP. A simple numerical model of the mixed layer is then used to explore the effects of this parameter on the dissolved oxygen budget.

3C2.5
The Glacial Arctic and Antarctic Oscillations and their Implications for Proxy-based Reconstructions
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Through the analysis of a sequence of coupled atmosphere-ocean climate simulations, Justino and Peltier (2005, GRL, vol. 32) demonstrated that the spatial and temporal variability of the Arctic Oscillation is expected to have been drastically different under glacial boundary conditions compared to today. In this presentation, we will present further evidence that a distinct form of temporal and spatial variability of the Antarctic Oscillation is also predicted to have existed during the LGM as compared to present-day conditions. As will be shown, these changes in the structure of extra-tropical climate variability will have to be carefully considered when temperature or precipitation/snowfall are estimated from paleo-proxy data for the LGM interval. We will furthermore discuss apparent changes in tropical-extra-tropical coupling between present-day and glacial conditions.

4C1.5
Gaseous Bromine Production from the Heterogeneous Reaction of Hydroxyl Radicals with Aqueous Salt Solutions
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Photochemically active bromine is believed to play an important role in the chemistry of the troposphere. Field measurements suggest that radical bromine produced by the photolysis of Br_2 may cause depletion of surface level ozone (O_3), particularly in polar latitudes at springtime. Though field and laboratory measurements support the proposed gas phase chemistry, the sources of Br_2 to the troposphere remain unclear. Marine algae and reactions of O_3 with sea salt particles, sea ice and frost flowers have been considered as potential sources.
We have used a rotating wetted-wall flow tube coupled to a chemical ionization mass spectrometer to investigate the formation of gaseous Br_2 from the heterogeneous reaction of hydroxyl radicals with aqueous salt solutions. For the first time we have observed that Br_2 is produced not only from acidic sodium bromide solutions, but also from acidic sodium chloride

solutions with varying concentrations of bromide similar to those encountered in sea water. These results are consistent with previous assertions that formation of Br_2 will occur as opposed to Cl_2 when sufficient bromide levels are present. We have explored this reaction as a function of bromide concentration and pH and will discuss the atmospheric implications of these findings.

3C2.4

Temporal Variability in The Expression of the Arctic Oscillation (AO) in the North Pacific

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The Arctic Oscillation (AO) and North Atlantic Oscillation (NAO) have been identified as important modes of variability in the climate system during the Northern Hemisphere (NH) winter. However, whether the AO or the NAO is more fundamental to the description of this variability, especially in the North Pacific, is still an open question. An important contributor to this uncertainty is our lack of knowledge of the low-frequency linkages between the North Atlantic and North Pacific Oceans. This paper represents a contribution to this debate through the description of inter-decadal variability in the expression of the AO and the NAO in the Northern Pacific during the 20th century. In particular, the authors show that the winter sea-level pressures in the North Pacific were positively correlated with the sign of the NAO during 1925-1950 and 1980-1998, which resulted in the classical AO pattern as representing the dominant mode in the NH. In contrast during the period 1951-1979, the winter sea-level pressures in the two basins were decoupled resulting in a dominant mode that more closely resembled the NAO. Using paleoclimate reconstructions, the authors show that this inter-decadal variability in the North Pacific climate began around 1850. The authors propose a possible mechanism that may be responsible for this variability that is driven by the Pacific Decadal Oscillation (PDO).

3C1.2

The Mini-MANTRA Campaign: An Intercomparison of Three Ground-Based Fourier Transform Spectrometers

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The Toronto Atmospheric Observatory (TAO) was commissioned in 2001, and a newly redesigned Bomem DA8 high resolution Fourier Transform Spectrometer (FTS) was installed as its principal instrument. Since 2002, spectra have been recorded routinely with both an InSb and an MCT detector, over a spectral range of 720 to 4300 cm^{-1} with a nominal resolution of 0.004 cm^{-1}. Using the SFIT2 optimal estimation retrieval algorithm, total and partial column concentrations of O_3, N_2O, CH_4, HF, HCl, NO_2, NO, CO, and HCN over Toronto have been determined. In March 2004, the TAO-FTS was formally designated as a complementary site of the Network for the Detection of Stratospheric Change (NDSC).

In Summer 2005, two Fourier Transform Spectrometers were brought to TAO to record simultaneous observations alongside the TAO-FTS. The UofT FTS is a newly modified Bomem DA5 moderate resolution spectrometer and PARIS-IR is a ground based adaptation of the ACE-FTS satellite instrument. Both of these spectrometers have previously flown in the MANTRA balloon campaigns and this intercomparison was intended not to only evaluate them for future flights but also to explore their utility as independent ground-based observing systems. Retrieved column concentrations of both tropospheric and stratospheric trace gases will be presented and the impact of optical design and instrument resolution on these results will be addressed.

1DPA2.11

Satellite and ground-based validation of Fourier Transform Spectrometer observations at the Toronto Atmospheric Observatory

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The Toronto Atmospheric Observatory (TAO) was commissioned in 2001, and a newly redesigned Bomem DA8 high-resolution Fourier Transform Spectrometer (FTS) was installed as its principal instrument. Since 2002, spectra have been recorded routinely with both an InSb and an MCT detector, over a spectral range of 720 to 4300 cm^{-1} with a nominal resolution of 0.004 cm^{-1}. Using the SFIT2 optimal estimation retrieval algorithm, total and partial column amounts of O_3, N_2O, CH_4, HF, HCl, NO_2, NO, CO, HCN, OCS, and C_2H_6 over Toronto have been determined. In March 2004, the TAO FTS was formally designated as a complementary site of the Network for the Detection of Stratospheric Change (NDSC). Total and partial column measurements made with the TAO FTS in 2003 and 2004 are being compared with those made by the Atmospheric Chemistry Experiment FTS (ACE-FTS) on board the SCISAT-1 satellite. Results for the long-lived species O_3, N_2O, CH_4, and HCl will be shown, along with available coincident measurements from OSIRIS on board the Odin satellite and SCIAMACHY on board the ENVISAT satellite. These measurements are then further compared with available coincident ground based observations made by a Brewer Spectrophotometer in Toronto and another Bomem DA8 Fourier Transform Spectrometer located at the Centre for Atmospheric Research and Experiments.

2C1.1 **INVITED / INVITÉ**

Chemistry-climate modelling: A SPARC perspective

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The coupling between ozone and climate is a major topic of atmospheric research. It pertains both to the role of ozone in climate, and to the role of climate change in the recovery of the stratospheric ozone layer. While process studies are essential to understand the mechanisms of this coupling, only fully coupled chemistry-climate models (general circulation models with interactive chemistry) can quantify the overall effects and provide credible predictions of the future. This talk will review the current state of chemistry-climate modelling from the perspective of SPARC science, highlighting some of the uncertainties and challenges, but also indicating where the different models seem to be providing some consensus.

3B2.5

Response of the middle atmosphere to CO2 doubling: Results from the Canadian Middle Atmosphere Model

Andreas Jonsson [1], *Victor Fomichev* [2], *Jean de Grandpré* [3], *Stephen Beagley* [2], *Charles McLandress* [1], *Kirill Semeniuk* [2], *Theodore Shepherd* [1]
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The Canadian Middle Atmosphere Model (CMAM) has been used to examine the middle atmosphere response to CO2 doubling. CO2 increases generally lead to a cooling of the middle atmosphere, but the response can be modulated by changes in circulation and by changes in the distribution of radiatively active gases. The model has been run both with and without coupled chemistry in order to determine the importance of the radiative feedback through ozone changes

on the CO2-induced cooling. Furthermore, simulations with and without prescribed changes in sea surface conditions have been used to examine effects of changes in the tropospheric climate on the middle atmosphere. The results show, as expected, a substantial cooling throughout the middle atmosphere that maximizes near the stratopause. The cooling leads to ozone increases of up to 20% in the upper stratosphere and lower mesosphere that increase solar heating and decrease infrared cooling, thus reducing the temperature response by up to 40%. The effects of tropospheric changes on the middle atmosphere are generally dynamical in nature and less significant than the radiative-photochemical response. There is a clear increase in lower stratospheric tropical upwelling, and thus in the Brewer-Dobson circulation, associated with tropospheric changes. However, no noticeable change in NH extratropical upward propagating planetary wave flux from the troposphere, or in Arctic winter-spring stratospheric temperature, has been found in the 30-year ensemble. This suggests that separating dynamical effects of climate change from natural variability in the Arctic stratosphere will require sophisticated statistical techniques.

1DPA4.2
Extreme waves in the NE Pacific
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The NE Pacific has one of the more severe wave climates in the world. Particularly in fall and winter, wave heights > 10m are not uncommon.
"Extreme waves" or "rogue waves" are commonly defined as waves with wave height

where is the significant wave height (typically the average of the highest one third of the waves). Superposition of random wave components leads to a Rayleigh distribution of

wave heights, and it is expected that one in 16000 waves is larger than . Furthermore, individual waves with say $1.5H_s$ occurring within a period of relative small waves would pose a significant danger to mariners but are generally not recognized as extreme waves.
I will present preliminary analysis of wave data from the NE Pacific combined with statistical simulations to assess the occurrence of extreme and dangerous waves in the NE Pacific.

4C1.2
Analysis of the impact of biomass burning on atmospheric CO and O3 using observations from the Tropospheric Emission Spectrometer
Dylan Jones [1], Kevin Bowman [2], Jennifer Logan [3], Helen Worden [2], Line Jourdain [2], John Worden [2], Greg Osterman [2], Susan Kulawik [2]
(Presented by / Présenté par ***Dylan Jones***)
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Atmospheric CO is a major precursor of tropospheric O_3, a harmful air pollutant and an important greenhouse gas. The Tropospheric Emission Spectrometer (TES) on the Aura satellite provides simultaneous vertical profile retrievals of tropospheric CO and O_3, offering a unique opportunity to better understand the processes regulating CO and O_3. Observations from TES show significantly enhanced concentrations of CO and O_3 in the southern hemisphere in November 2004, as compared to simulations from the GEOS-Chem model. Using both a linear inverse modeling and a chemical data assimilation approach, we examine the factors responsible for these high concentrations of CO and O_3. The inversion analysis of the CO data suggests enhanced emissions of CO from biomass burning in Australia and Indonesia, compared to the climatological emission inventory in the model. To assess the impact of this biomass burning on the distribution of O_3, we conduct forward modeling simulations of O_3 using the optimized CO emissions. We also

assimilate vertical profiles of CO and O_3 from TES in the GEOS-Chem model using a suboptimal Kalman filter. The assimilated CO and O_3 distributions are compared with those obtained from the forward model simulations, constrained by the optimized surface emissions, to isolate systematic errors that are not accounted for by the inversion analysis.

2B2.3
How to get NWP model ICs from satellite ozone data in 3 easy steps
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Satellites provide uniform data coverage globally. Thus, their data have the potential to reduce analysis errors in data sparse areas significantly, thereby improving numerical weather prediction (NWP) forecasts. We describe a methodology to generate NWP model initial conditions (ICs) from satellite total column ozone data based on Davis et al. (1999). This methodology involves the following steps: 1) derive a mean potential vorticity (MPV) field from total column ozone data using correlation coefficients and linear regression least squares best fit line parameters, 2) convert the 2-D MPV field to a 3-D potential vorticity (PV) field, 3) invert the 3-D PV field to obtain model ICs (see Davis and Emanuel, 1991). We find that the correlation coefficients vary distinctly with year, latitude and 10-degree longitude bin as well as with the analysis and the length of the statistics-generating period used, but that strong correlation coefficients can be obtained despite ozone/MPV time differences as great as seven hours.

Davis, C. A., and K. A. Emanuel, 1991: Potential vorticity diagnostics of cyclogenesis. *Mon. Wea. Rev.*, 119, 1929-1953.

_____, S. Low-Nam, M. A. Shapiro, X. Zou, and A. J. Krueger, 1999: Direct retrieval of wind from Total Ozone Mapping Spectrometer (TOMS) data: examples from FASTEX. *Quart. J. Roy. Meteor. Soc.*, 125, 3375-3391.

2DPA6.19
Impact of Long-Range Correlations on Trend Detection in the Total Ozone
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For the purpose of trend analysis memory is an issue. For time series with strong serial correlations it is difficult to distinguish a trend from natural variability. All previous studies of trends in total ozone used a generalized least squares estimate with autoregressive model of the first order for the residuals. Based on the calculated in this way variance of the trend one can derive the number of years required to detect an expected positive trend in total ozone at a certain level of statistical significance. In our study we revise these results starting with the assumption that residuals of the total ozone time series are long-range correlated, i.e. their autocorrelation function decays by the power law.

4C3.2
Canadian SOLAS: Marine photochemistry, ocean optics and air-sea exchange
William Miller [1], Rene-Christian Bouillon [4], Lori Ziolkowski [3], Jane Sherrard [2], Cedric Fichot [1]
(Presented by / Présenté par ***William L. Miller***)

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Our Canadian SOLAS project had 3 objectives : (1) photochemical Apparant Quantum Yield (AQY) determinations, (2) oceanic optical measurents, and (3) optical/photochemical modeling. These general objectives are connected and focused on AQY determinations of DMS photolysis in the SERIES and SABINA cruises as well as CO2 photoproduction in the Mid Atlantic Bight (w/ D. Kieber, SUNY Syracuse). Optical data for UV and SeaWiFS wavelengths were collected on all SOLAS cruises in the form of in situ optical profiles, insolation data and CDOM samples. Using these data sets, we have estimated the significance of DMS photochemistry relative to biological sinks in the SERIES expedition and, by analyzing spatiotemporal AQY variations in SERIES and SABINA, have found that both CDOM and nitrate concentrations control DMS photolysis in both oceans. Examining the photochemical production of CO2 in the Mid Atlantic Bight by comparing calculations to production rates from deck incubations done in sunlight, we confirm that our AQY/optical approach accurately reflects analytical observations. Following connections made during SERIES, we also have optical and CO photochemical data from a New Zealand SOLAS sponsored iron addition experiment in the southern ocean (w/ C. Law et al.). Altogether, this project has contributed a new understanding of the role of photochemistry in DMS, CO2, and CO oceanic cycles and, demonstrates that accurate UV optical and photochemical efficiency (AQY) data allow quantitative model development.

3B2.2
Simulating effects of increasing greenhouse gas concentrations on stratospheric ozone
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While chlorine loadings in the atmosphere are expected to decrease towards pre-ozone hole levels by 2060, the greenhouse gases (GHGs) burden is rising continuously and may in turn modify significantly the stratospheric ozone layer.

In this study, the response of stratospheric ozone to increases in greenhouse gas concentrations between 1979 and 2060 is investigated using the new interactively coupled chemistry - general circulation model IGCM-FASTOC. The IGCM (Intermediate General Circulation Model) is a relatively fast general circulation model (GCM) with parameterizations of an intermediate level of complexity, and the new chemistry scheme FASTOC (Fast STratospheric Ozone Chemistry) is an efficient input-output model composed of precomputed non-linear functions.

Multiple time-slice simulations are performed to allow for the quantification of individual processes involved in the response of stratospheric ozone. Results from these simulations will be discussed in this talk.

1DPA4.3
Nonlinear principal component analysis of noisy climate data
W.W. Hsieh , A.J. Cannon
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With very noisy data, overfitting (i.e. fitting to noise) is a serious problem in nonlinear signal extraction. For nonlinear regression, having plentiful data eliminates overfitting, but for nonlinear principal component analysis (NLPCA), overfitting persists even with plentiful data. Thus simply

minimizing the mean square error is not a sufficient criterion for NLPCA to find good solutions in noisy data, hence two new approaches are proposed:

(1) A new index is proposed which measures the disparity between the nonlinear principal components computed for a data point and for its nearest neighbour. This index, based on the Spearman rank correlation, tends to increase with overfitted solutions, thereby providing a diagnostic tool to determine how much regularization (i.e. weight penalty) should be used in the objective function of the NLPCA to prevent overfitting. Tests are performed using autoassociative neural networks for NLPCA on synthetic and real climate data (tropical Pacific sea surface temperature and North American winter surface air temperature). (2) To make the NLPCA method robust to outliers, further tests involve using the L_1 norm to calculate the error instead of the traditional L_2 norm.

2C4.8
Can nonlinearity enhance predictability?
Z. Ye , W.W. Hsieh
(Presented by / Présenté par ***W.W. Hsieh***)
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Since Lorenz (1963), it is known that nonlinearity in a dynamical system can lead to chaos and decline in predictability. Here we present the rather surprising result that greater nonlinearity can lead to enhanced predictability in the El Niño-Southern Oscillation (ENSO) system and in the Lorenz system. In an intermediate coupled model of the tropical Pacific, changing the background state can lead to ENSO oscillations with greater nonlinearity and lower frequency. The lower frequency led to enhanced predictability. With the Lorenz (1963) system, changing model parameters also resulted in chaotic oscillations of greater nonlinearity and lower frequency, again leading to enhanced predictability.

1DPA4.7
The stationary wave response to topography in a barotropic model
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The stationary wave response to topography is studied in the Geophysical Fluid Dynamics Laboratory¡¯s T85 barotropic model. We add damping into the model and integrate the flows to steady states with the linearized and full nonlinear barotropic vorticity equations on the sphere, respectively. The stationary wave pattern of each simulation is then obtained as the deviation from zonal symmetry of the time mean flow. The mixed time-space decomposition (Peixoto and Oort, 1992) is used to analyze the difference between the linear and nonlinear response. In the decomposition, the divergence of the potential vorticity flux is divided to several parts such as the stationary nonlinearity, the transient eddy flux, and the terms involving topography. Their contribution to the stationary wave response is investigated by treating them as external forcings on the right hand side of the linearized equation.

3C2.6
Increasing potential destructiveness of North Atlantic hurricanes and anthropogenic forcing of sea surface temperature.
Robert Scott , Christina Holland
(Presented by / Présenté par ***Robert B. Scott***)
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Emanuel (Nature, 2005) proposed a measure of hurricane potential destructiveness as the total, seasonally integrated, energy dissipated by all hurricanes within a given basin, and found this

index (energy dissipation index = EDI) has at least doubled in the last 30 years for the North Atlantic, with most of the increase since the early 1980s. The cause of this increase was left unexplained. We propose an explanation and support it with analysis of observational sea surface temperature (SST) data since 1982. We show that the increase in EDI has resulted mostly from increases in hurricane frequency and duration. We find a particular regional pattern of SST is important, and then relate this pattern to that forced by anthropogenic forcing in a global coupled climate model (GFDL CM 2.1). As a proxy for SST cooling by upwelling subsurface waters, we used daily observational SST data, to estimate the difference in SST just before and after the passing of each North Atlantic hurricane since 1985. There was *no trend* in the seasonal averages, suggesting that warming of the subsurface ocean has *not* had a significant impact via reducing the negative feedback associated with hurricanes upwelling deeper waters. The proposed mechanism and supporting evidence are consistent with anthropogenic forcing playing a role in driving the increase in hurricane potential destructiveness.

1B4.3
Characteristics of Cyclones and Vapor Transportation over the North-western Pacific Region
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Explosively developing cyclones frequently appear over the north-western Pacific Ocean as well as north-western Atlantic Ocean. These cyclones play an important role for the global vapor and energy transportation point of view. This presentation describes the behavior of cyclones over the north-western Pacific region and their vapor transportation using JMA global objectively analyzed dataset (GANAL). Cyclones were classified cyclones into three types depending on positions of formation and rapid development: Okhotsk-Japan Sea (OJ), Pacific Ocean-land (PO-L) and Pacific Ocean-ocean (PO-O) cyclones. OJ cyclones frequently appeared in late fall and had the smallest deepening rate of the three, PO-L cyclones had medium deepening rate and frequently occurred in early and late winter, and PO-O cyclones mainly occurred in midwinter and had the largest deepening rate. These characteristics closely connected to the larger scale atmospheric conditions and have an important effect on the latent heat release near the cyclone center. After the development, cyclones transport moisture for a considerable distance. OJ cyclones transport moisture toward Kamchatka Peninsula and Bering Sea; PO-L cyclones transport eastward; and PO-O cyclones have larger northward transport component.

3DPA2.9
Field Accuracies of Canadian Rain Gauges
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retired
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The field accuracy of rain gauges is present in relation to the introduction since 2001 of the Hydrological Services TB3 tipping bucket rain gauge and the Geonor 200-B precipitation gauge into the Canadian networks. As well the accuracy of the previous automated and manual rain gauges are presented. These accuracies, where possible, are related to pit gauges total rainfall measurements.

3C3.1
General Circulation and Water Masses in Amundsen Gulf, Canadian Arctic
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Even if several studies have been published on the Southern Beaufort Sea (Aagaard, 1984; Aagaard and Carmack, 1994; Carmack and Macdonald, 2001; Pickard, 2004) and the physical processes are well known, the extreme south-eastern part of this region and the adjacent Amundsen Gulf remains almost unstudied. We already know the importance of this region in terms of biology because of the presence of the so-called Cape Bathurst Polynya (Arrigo and VanDijken, 2004; Carmack et al., 2004) and we can envision its importance in terms of physical processes because of its location at the mouth of the Northwest Passage.
In this study, we are building a detailed physical description of the Amundsen Gulf using CTD (Conductivity, Temperature, Depth), MVP (Moving Vessel Profiler), ADCP (Acoustic Doppler Current Profiler) and moorings data from the CASES program. We detail the water masses distribution in the region with an emphasis on the relative importance of Pacific and Atlantic waters. We also describe the regional surface and deeper circulation in the gulf, highlighting the regions that are presenting special interest. We discuss the seasonal variability and try to detect the presence of annual cycle and possible inter-annual variability focusing on the "Cape Bathurst Section" witch represents the limit between the Gulf and the Beaufort Sea. This particular section has been visited several times and was equipped with five moorings, providing us with a multi-year time series.

4DPA7.2
Modelling of dimethylsulfide dynamics in the NE Pacific
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The subarctic Northeast Pacific is known as an oceanic High-Nutrient–Low-Chlorophyll (HNLC) region characterized by little seasonal variability. In spite of the low biomass, the concentrations of the climate-active gas dimethylsulfide (DMS) may be extremely high (> 20 nM) in summer. Current parameterizations used in climate models do not reproduce these high DMS emissions. Causes for the high DMS levels, and their potential link with the Fe-limited conditions prevailing at Ocean Station Papa (OSP), were investigated during the C-SOLAS program. DMS observations at OSP and results from the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) conduced in July 2002 were used to develop a new ocean DMS production model for the NE Pacific. The model is based on an existing 7-component ecosystem model (2 size classes for both phytoplankton and zooplankton) with Fe limitation calibrated at OSP. Sulfur fluxes linked to DMS cycle were introduced in the model in parallel with the nitrogen fluxes. New parameterizations of DMS yield (efficiency of bacterial DMS conversion) and DMS photodegradation by UV light were defined. This biogeochemical model was coupled to a physical upper ocean turbulent model (GOTM; General Ocean Turbulent Model) and used to simulate mean seasonal cycle of marine DMS at OSP and to address the sensitivity to iron-induced changes in the biological cycling of DMS.

4B3.2
Mesoscale Fe Enrichment Produces a Large Diatom Bloom, Draws Down CO2, But With Limited Production of DMS and Carbon Export in the NE Subarctic Pacific
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The Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) was conducted in the NE subarctic Pacific, one of the three major high nitrate low chlorophyll (HNLC) regions of the world where Fe limits primary productivity. SERIES is part of the Canadian SOLAS network project. During the first phase of the bloom, small phytoplankton (mainly prymnesiophytes) increased and there was a record increase in dimethylsulphide (DMS). During the second phase, the bloom was dominated by large pennate and centric diatoms and chlorophyll *a* was 8-fold higher than initial values. The fugacity of CO_2 (fCO_2) decreased from 340 to 260 µatm and DIC from 2010 to 1970 µmol kg^{-1}. In contrast, DMS decreased and often became undetectable due to the metabolism of DMSP by bacteria. There was no significant difference in the zooplankton community dominated by small copepods inside the patch and outside. The bloom was terminated on Day 20 by silicate and low Fe concentrations, while sufficient nitrate and phosphate remained. Using sediment trap information and other data, it was estimated that <5% of the carbon associated with the Fe-induced bloom, was exported below the mixed layer depth during this 30 day experiment. About 25% of the Fe-enhanced primary production in the mixed layer was channeled through the microbial food web, thus reducing the amount of organic carbon for export. Hence large scale Fe 'fertilization' may not be a viable solution to drawing down CO_2 and offsetting global warming

4B4.2

Changes in the Arctic Oscillation under global warming simulated by CCCma CGCM2

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Changes in the Arctic Oscillation (AO) under global warming were analyzed by using the data of 200-year simulations conducted by the Canadian Centre for Climate Modelling and Analysis (CCCma) second generation coupled general circulation model (CGCM2) with the "is92a forcing scenario". We found during the winter season a nonlinear teleconnection pattern associated with AO in the sea level pressure (SLP) field, which is mainly quadratic with respect to the AO index, indicating significant positive SLP anomalies stretching westward from the Norwegian Sea to the Pacific West Coast, and negative anomalies over Euro-Atlantic and northern Russia, broadly consistent with observed SLP data.

Under global warming, the model AO over the Atlantic sector weakens, in agreement with the nonlinear teleconnection. Meanwhile, the nonlinear
teleconnection shows notable changes in its spatial structure, with the SLP anomaly centre expanding to the Pacific West Coast, which can also be identified from the observed data.

4C1.4

Reactive bromine outflow from the Arctic boundary layer to subpolar latitudes and its photochemical impacts: GEM-Arctic simulations

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The bromine explosion, which takes place in the Arctic springtime, is the extensive release of reactive bromine species from the snowpack and possibly from frost flowers. It exerts a significant influence on the photochemistry of ozone, hydrocarbons, and mercury in the Arctic boundary layer. GOME satellite pictures have revealed that the outbreak of BrO is common and widespread over the Arctic Ocean and Hudson Bay and their surrounding landmass from March to May. In

addition, a considerable amount of BrO escapes from the boundary layer to the free troposphere as evidenced by aircraft- and balloon-borne measurements. Here we investigate the possibility of outflow of reactive bromine species from the Arctic to subpolar latitudes using the GEM-AQ with the addition of Arctic chemistry. The model accounts for gas-phase bromine chemistry as well as standard air-quality chemistry and heterogeneous bromine chemistry for which Canadian Aerosol Module (CAM) provides online spatial distributions of sulfate and sea-salt aerosols. Several episodes of bromine outflow to subpolar latitudes are discussed in light of supporting observations of surface ozone mixing ratios in the marine boundary layer and spatial patterns in the GOME BrO columns. We also discuss the impacts of a bromine-rich air mass, transported from the Arctic over the windy subpolar ocean, on the photochemistry of ozone, NOx, and DMS, and on halogen release from sea-salt aerosols.

1DPA1.4
Delivery of Aviation Weather Services in Canada
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The Aviation Weather Web Site (AWWS) (www.flightplanning.navcanada.ca) is a cornerstone for the delivery of aviation weather to users inCanada. Since its inception in August, 2001 it has reliably provided data services without restrictions to a variety of aviation users. Users are expected to consult the AWWS at home , office or though Pilot Information Kiosks (PIK) at many airports across Canada. Weather briefings are available through toll free numbers to Flight Information Centres. The FIC's have a dedicated access to the AWWS as well to the same weather data through the satellite based Aviation Weather distribution Service (AWDS). Pilots may choose to file a flight plan through the FIC's or online. The access to AWWS data (aviation weather and NOTAM' s) is organized along the following lines: Local area - access to data within 50 NM of an aerodrome; Region - access to data in a Graphical FA region; Route - access to data along a flight route Forecast and OBS - free form access to data. Users may save favorite local, regions or routes in their flight folders on their user account and recall these before departure with updated information. The same updated flight folders can be sent to the user's email address through the Weather Mail service. A popular recent addition to the AWWS has been have been RVAS (remote video acquisition system) imagery and Automated Supplementary Enroute Predictions (ASEP). ASEP provides the users tailor made products extracted from EC's GEM regional model along the user's flight route either at flight level in plan view or in cross sections.

1C2.2
SCRIBE past present and future
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SCRIBE was implemented within EC as the principle tool for the production of public forecasts. Since July 2005 the Storm Prediction centres edit weather element forecasts which can be used to produce a variety of different products including the public forecasts. The public forecast bulletins are no longer edited by the forecaster. Since the implementation of Scribe 3.9 in Dec. 2005, the icons on WeatherOffice are also produced from the same weather element files. In the near future the city pages and the weather element files will be available in XML format. Marine SCRIBE slated for the late spring 2006 will produce marine weather element files , forecast bulletins, MAFOR and NAVTEX bulletins as well as synoptic based weather warnings. In the fall 2006 the public SCRIBE will likely be extended to day 7 or beyond based on ensemble forecasts. In the plans are SCRIBE - AQ. AQ forecasts will be based on the public weather element forecasts and air quality forecast guidance.

2DPA5.3

Integrating satellite observations of atmospheric CO2 and CO to quantify regional carbon fluxes

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Satellite measurements of atmospheric CO_2 will dramatically enhance the coverage of the existing observational network for CO_2. These space-based observations, when combined with measurements of other atmospheric trace gases, have to potential to enhance significantly constraints on terrestrial carbon fluxes. We conduct an inversion analysis to assess the utility of future satellite observations of CO_2, from instruments such as the Orbiting Carbon Observatory (OCO), to quantify surface fluxes of carbon on regional scales. We examine the additional constraints on carbon fluxes offered by integrating these data with satellite measurements of atmospheric CO. Using the GEOS-CHEM global chemical transport model, we generate a pseudo dataset of space-based measurements of atmospheric CO_2 and CO. We perform a coupled inversion analysis to quantify CO_2 and CO fluxes on regional scales, exploiting the correlations between CO and CO_2 to isolate better biospheric and anthropogenic fluxes of CO_2. We show that accounting for the correlation between CO and CO_2 in the model transport error, in particular, enables the inversion to distinguishing between anthropogenic and biospheric fluxes of CO_2 on regional scales.

4DPA7.13

Can seasonal and spatial variation of methyl iodide in the NW Atlantic reveal some clues to its oceanic production?

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The ocean is a significant source of atmospheric methyl iodide (CH_3I), but the main oceanic sources of CH_3I are not yet understood. The seasonal investigation of Canadian Surface Ocean Lower Atmosphere Study (C-SOLAS) in the NW Atlantic in 2003 provided an unprecedented opportunity to study the spatial and seasonal variation of oceanic methyl iodide in this open ocean area. Data collected during this field campaign have offered some clues to the oceanic production of CH_3I.

The concentration of CH_3I in the NW Atlantic was observed to vary with season, with mixed layer levels ($[CH_3I]_{ML}$) being high in summer, low in spring, and moderate in fall. In the same season, the Slope, Subtropical Gyre West/East, North West Continental Shelf, Gulf Stream, and North Atlantic Drift biogeochemical provinces were generally associated with high concentration and production rate of CH_3I in the surface mixed layer. In contrast, concentration and production rate of CH_3I were relatively low in the Arctic Water and Boreal Polar Water provinces.

No conclusive evidence for either phytoplanktonic or photochemical production pathway was obtained from this field study. However, results from some exploratory regression models that were developed from the field data in this investigation have indicated that the depth-averaged daily radiant exposure ($H_{325,ave}$ and $H_{PAR,ave}$) and water temperature (T) can explain about 50% of the variation of CH_3I concentration in the surface mixed layer. It is possible that these physical

factors can influence the CH_3I production rate of the unidentified biological or photochemical producers in the ocean.

2B4.3

Four model set-up for seasonal forecasting at the Canadian Meteorological centre

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A study of the impact on the skill of a multi-model ensemble forecast system for seasonal forecasts was made using seasonal hindcasts for 4 models (RPN SEF, RPN GEM and CCCma AGCM2 and AGCM3) covering the period 1969-2000. Temperature and precipitation anomaly forecasts were generated over the hindcast period 1969-2000 using ten lagged members of 1 model (10 member ensemble), 2 models (20 member ensemble), 3 models (30 member ensemble) and 4 models (40 member ensemble). Serial correlation was calculated for 1, 2, 3 and 4 models respectively for the twelve four-month seasons (the first three months of each season was verified). Skill increases with the number of members as well as with the number of models. Also, for the same number of members it is always better to use more models. For example, using 1 member from 4 different models is better than using 6 members from 1 model. The improvement from passing from 1 model to 2 is greater than to go from 2 models to 3 which is also greater than going from 3 to 4 models. The rate of increase of the correlation with increasing number of member also saturates and tends towards zero. Therefore it is a better choice to increase the number of models than to increase the number of members. The impact of adding members/models on probabilistic forecasts has also been examined. It is clear that having more members (from different models) have a significant impact on the reliability of probabilistic forecasts.

1C2.5

Products based on the Canadian Ensemble Prediction system

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The Ensemble Prediction System (EPS) has been running operationally at the Canadian Meteorological Centre (CMC) since February 1996. Several improvements have been brought to the system since then, amongst which there is the doubling of the number of members performed in August 1999 and the increase in horizontal resolution of the members implemented in July 2001. More recently (December 2005), the Ensemble Kalman Filter in the EPS was updated as well as the model physics parameterizations. In that set-up the Canadian EPS has sixteen members, eight of them produced by integrating the SEF model and eight more by integrating the GEM model; the model integrations are done from sixteen perturbed analyses; each member has its own physics parameterization; integration of the members is performed out to sixteen days in the 00 and 12 UTC production cycles. A set of new products have been developed on the EPS outputs: Bayesian Model Averaging is used to generate probability density function for temperatures, probabilities of exceeding different thresholds for different variables are now available. This presentation will give an overview of the new products that have been recently developed. The presentation will also give a brief overview of the North American Ensemble

Forecast System (NAEFS) project which involves operational exchange of ensemble members between Canada and the United-States.

1C2.6
A comprehensive diagnostic verification of probability of quantitative precipitation forecasts (PQPF) from the Canadian Ensemble system
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One of the great promises of ensemble forecasting is that it would be able to provide estimates of the probability of extreme or "high impact" precipitation events such as high rainfall amounts, or the probability of extended dry periods. The ability to check on the delivery of this promise is hampered, however, by the infrequent nature of such events. We have now collected forecasting experience from the Canadian ensemble system in the form of nearly 4 years of forecasts for all of Canada. These data have been matched with verifying precipitation observations from 35 primary stations, which have been carefully quality-controlled using methods independent of models.

Forecast PQPF for thresholds ranging from 1 mm to 50 mm over periods of 24 h to 10 days were evaluated using methods appropriate for verification of dichotomous variables, such as reliability (attributes) diagrams, the relative operating characteristic (ROC) curve and the Brier Skill score. These same measures were used also to have closer look at the forecasting of climatological extremes at all stations, defined as the upper 10, 5 and 1% thresholds of the long term climatology. And finally, on the dry side, we looked at the system's ability to forecast the probability of dry periods of various lengths, from 3 to 10 days.

This presentation will include the most interesting and significant verification results from the study.

1DPA1.9
The Extreme Forecast Index: A diagnostic tool to aid in the interpretation of ensemble forecasts
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The extreme forecast index is a number between -1 and +1 which indicates where a current forecast ensemble distribution falls in terms of all previous forecasts of ensemble distributions for a particular location. As applied to precipitation, for example, values near -1 indicate that the current forecast is drier than most or all previous forecasts, while values near +1 indicate an ensemble prediction of wetter conditions than the model normally predicts. The reference is model climatology, which means that the index takes into account any forecast biases in the model.

The index is useful for summarizing an ensemble prediction, giving an alert if extreme conditions are expected. We have developed the index for Canada's ensemble system, following work done at ECMWF, and have tested it on many cases. We are in the process of verifying the index, and implementing it on a test basis at CMC.

The presentation will show the more interesting case studies that have been done, including the summer 2005 extreme precipitation events in Southern Alberta.

1B2.4
Radar Analysis of the Toronto Air Francce 358 Incident of 2 Aug 2005

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On 2 Aug 2005, Air France AF358 slid off run 24L at Toronto Pearson Airport. Remarkably, there were 309 survivors and no deaths even though the plane was completely destroyed by fire. AF358 landed long, about half way down the runway. It was not able to stop in time, even though there was sufficient runway to stop. Two important questions are: why did the plane land long, why was the plane not able to stop. Severe thunderstorms were in the area and Doppler radar showed a large downburst, gust front and heavy rain as potential factors in the incident. The first two factors are examined to determine if they were the cause of any problem, while the last factor may have contributed to poor runway conditions or visibility. A radar data analysis will be presented for the potential impact that weather may have had on the incident.

4DPA6.4
The Contribution of Naturally Occurring Sea Salt to Modelled Fine Particulate Concentrations in the Atlantic Region
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It is important to quantify natural background levels during periods of elevated particulate matter (PM) when determining the achievement of the Canada Wide Standard. Quantifying the proportion of naturally occurring sea-salt in $PM_{2.5}$ measurements in the Atlantic Region would help in the development and validation of Chemical Transport Models (CTMs) and, as a result, provide better estimates of the trans-boundary contribution to $PM_{2.5}$ concentrations as predicted by the models.

It is expected that sea-salt aerosols affect gaseous and aqueous chemistry in addition to mass and composition of aerosols, at least near the ocean. Although it is well known that sea-salt aerosols predominately occur in the coarse particle fraction (2.5-10 m), sea-salt does account for a portion of the fine fraction (<2.5 m). During high wind events (U_{10} >7 m/s), or near a big surf zone, it is possible to generate substantial sub-2.5 micron sea-salt aerosol. As sea-salt aerosols are generated by wave activity, sea-salt fluxes are different in the surf zone compared to the open ocean. By comparing model results and measurements taken in the open ocean, as well as at coastal and inland locales, the contribution of sea-salt aerosol to Atlantic Regional $PM_{2.5}$ levels may be better understood.

In the first phase of a three phase project, the contribution of naturally-sourced sea salt to modelled $PM_{2.5}$ concentrations will be assessed using A Unified Regional Air Quality Modeling System (AURAMS). Model results will be compared to measurements at Atlantic coastal sites and Sable Island during a high PM event in February 2005.

2B1.4
Semiannual component of CPT temperature and height over tropics
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Spatial distributions of semiannual component of CPT and UT/LS temperature and height are investigated with rawinsonde data over Indonesia and ERA-40 data over tropics. The seasonal variations of CPT temperature and height are not completely annual over Indonesia, but close to semiannual with temporal increase (secondary maximum) on February and April--May, respectively [Hashiguchi et al., 2006]. The amplitude of the semiannual component is approximately half that of the annual component over 5 degree N - 5 degree S, and decreases largely with latitude.

In harmonic analysis with ERA-40 data over the tropics, large amplitude of semiannual component more than 0.5 K appeared only at 70 hPa and in eastern hemisphere (western side of 150 degree E) and south America at 100 hPa. In height, large amplitude appeared in 100--300 hPa with coherent phase and similar geographical distribution with that in temperature at 100 hPa. Secondary maximum is directly response to zonally inhomogeneous tropospheric heating in seasonal scale in CPT height, but not in CPT temperature.

2B2.4
The assimilation of Radio occulation data into the Unified Model
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The results of the assimilation of data from the GPS radio occultation mission CHAMP into the Met Office's Unified Model are analysed. Despite the limited number of profiles provided by the satellite, a positive impact has been detected both in the analysis and in the forecast. The advantages and the disadvantages of the current assimilation technique are examined. During 2006 two major operational GPS radio occultation missions are scheduled to be launched: COSMIC and GRAS. Between them, they will provide roughly 3000 occultation per day. If the results of our preliminary trials are confirmed by the new missions, it appears reasonable to assume that GPS RO will become a significant source of data for most NWP centres.

1C1.7
Mesospheric cloud simulations and water vapour retrieval from WINDII observations
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A 1-D version of the CARMA (Community Aerosol and Radiation Model for Atmospheres) model and satellite observations of temperature and water vapour by the HALOE (Halogen Occultation Experiment) experiment on UARS are used in a study of the physical properties of mesospheric clouds (MC) (known also as Polar Mesospheric Clouds (PMC)). The median radius and the number density of the iced particles formed was found to range between 20 – 40 nm and 100 – 700 cm^{-3} respectively, while the dominant microphysical process affecting the size of the iced particles proved to be the condensational growth. The results of the simulations showed that the 1-D CARMA model is capable of simulating iced particle layers, although underestimating the life-cycle and size of the particles. Employing considerations of particle scattering theory and backscatter ratio, profiles retrieved from volume Rayleigh scattering radiances observed by the WINDII (Wind Imaging Interferometer) on UARS, allows the derivation of plausible water vapour profiles associated with the PMC observations. The study conducted has shown that the properties of MC can satisfactory be described and retrieved from satellite observations of mesospheric temperature, water vapour, and backscatter ratios by employing a 1-D microphysical model.

2DPA6.7
Quasi-Two Day Wave, Gravity Wave and Mean Flow Interaction in the Extended CMAM
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The quasi-two day wave (QTDW) is a persistent feature of the mesopause region and is thought to be produced by baroclinic instability of the summer mesospheric jet. This region of instability is

due to the strong vertical gradient of the zonal-mean zonal wind produced by gravity wave drag. The QTDW acts to reduce the instability of the jet and the gravity wave drag acts to maintain it. This interplay between the QTDW and the gravity wave drag, and its effect on the mean flow are examined in the extended version of the Canadian Middle Atmosphere Model. Differences between the southern and northern hemispheres, such as the persistence and strength of the QTDW, are also discussed.

3B3.1

Pan-Arctic ocean modelling and coupling to a regional model of the Canadian archipelago

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The Arctic ocean model of Holloway and Sou (2002) in its extended version (North Atlantic included) has been run for the last 50 years. The model is based on a classic MOM release and make use of the "Neptune effect" based on statistical mechanics to overcome its resolution limitation in time and space. However the model suffers from lack of good resolution in the vertical and a good parametrization of turbulence in the surface mixed layer which will be addressed in future developpement. This model does not show any trend in sea ice extent during the whole simulation. The coupling to a regional model of the Canadian archipelago will be briefly discussed. This model has also been coupled to a simple not-calibrated NPZD model of the primary/secondary production. Preliminary results shows a reasonable seasonal cycle of the biology.

2DPA6.2

GPS radio occultaion: monitoring the tropopause.

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It is hard to underestimate the importance of a precise knowledge of the tropopause location. For weather forecasting its anomalies are important precursors of developing systems. In the climate research the trend in the average altitude of the tropopause is considered an extremely relevant proxy of tropospheric temperature changes. Before the satellite era all information concerning the upper structure of the troposphere came from the radiosonde network. The introduction of satellite profilers (microwave and infrared) has largely contributed to an increase in the amount of information available. Nevertheless the typical vertical resolution obtainable from a nadir looking passive sensor is not high enough to resolve the small scale feature associated with tropopause height fluctuations. The paper examines two possible ways to use the GPS radio occultation to obtain reliable information on the global structure of the tropopause.

2DPA5.9

Modelling Analysis of Primary Controls on Carbon Exchanges across Fluxnet-Canada Coniferous Forest Sites

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Forest properties, soil conditions and weather generally control carbon dioxide exchanges between ecosystem and atmosphere. In this study we used a coupled soil-plant carbon and nitrogen cycling model with Canadian Land Surface Scheme to compare carbon exchanges from September 2003 to December 2004 in six mature/old conifer forest sites from east to west coast of Canada. These sites are part of the Fluxnet-Canada Research Network. The sites located in BC and ON are temperate forests while those in SK (two), QC, and NB are boreal forests. Besides contrasted weather conditions, forest structure and biomass, litter stock, soil organic matter, nitrogen content, and physical properties vary among these sites. Model results indicated that weather conditions played a leading role in carbon exchanges. Leaf area index was one of the primary controls on gross and net ecosystem carbon exchanges. Canopy nitrogen content and leaf area index determined leaf Rubisco-related nitrogen, which was nonlinearly related to the maximum rate of Rubisco activity. Canopy nitrogen was tightly associated with root uptake from soils, in which N nutrient availability is determined by soil organic C/N ratio and soil respiration. Together with temperature, it impacted yearly maximum Rubisco activity that varied remarkably among six forests. Ecosystem respiration differences among sites mostly resulted from living biomass and litter stocks, while soil organic matter role appeared secondary over the course of this study. Forest floor litter layer (and subsurface peat layer) also played an important role in redistributing water into soil root zone, which might contribute seasonal differences in carbon exchanges among the sites, especially when seasonal drought appeared.

3C2.2

Uncertainties in statistical downscaling model outputs from two global climate models: a case study in Northern Canada

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Fine resolution climate change information for use in impact studies can be obtained using statistical downscaling (SD) methods to relate the large or coarse scale climate variables from Global Climate Models (GCMs) with local or station scale observations. Uncertainty analysis is used to make a quantitative evaluation of the reliability of the downscaled climate data representing local climate conditions in northern Canada. The performance of the multiple regression-based statistical downscaling method (SDSM) in reproducing the observed daily Tmax, Tmin and Precipitation total for a baseline period is evaluated using climate predictors derived from NCEP reanalysis data and those simulated by CGCM2 and HadCM3 global climate models. The Wilcoxon Signed Rank hypotesis-testing and bootstrap confidence-interval estimation techniques are used to make the uncertainty analysis on the downscaled meteorological variables. The results show that while the NCEP-driven downscaling mostly reproduced the mean and variability of the observed data for the baseline period satisfactory some of the GCM-driven downscaled data are found to be significantly different from the observed, especially for the case of CGCM2-driven downscaling of temperature data. The study also shows that the climate variables downscaled with GCM predictors can reasonably reproduce the observed values only if the predictors generated by the GCM are comparable to that of NCEP by which the downscaling model is calibrated. Therefore, before implementing statistical downscaling techniques for climate scenario generation, an in-depth analysis should be done to ascertain how good each potential predictor variable is simulated by the GCMs.

4C2.5

The degeneration of internal waves in lakes with sloping topography

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Internal solitary waves are ubiquitous features of lakes and oceans. Generated in deep water, these waves are capable of propagating to coastal regions where they may shoal, thus releasing their energy directly to the benthic boundary layer via turbulent mixing and dissipation. Laboratory experiments were conducted to quantify the downscale temporal energy flux in lakes, associated with the dispersive degeneration of basin-scale internal waves into solitary wave packets. The rotation of the Earth was neglected and the two-layer stratified system was subjected to a single forcing event creating available potential energy at time zero (PEo). The internal wave field was initially decomposed as a standing seiche, a progressive nonlinear surge and a high-frequency solitary wave packet; where wave energy was ultimately lost due to internal solitary wave breaking along sloping topography. The ratio of the steepening timescale, required for the evolution of the solitary waves, to the traveltime of these waves controlled their development within the domain. The energy loss along the slope, the mixing efficiency, and the breaker type were modeled using appropriate forms of an internal Iribarren number, defined as the ratio of the boundary slope to the wave slope (amplitude/wavelength). Our results indicate that a periodically forced system with sloping topography may sustain a quasisteady flux of 20% of PEo to the benthic boundary layer at the depth of the metalimnion. It is recommended that this flux, which occurs through the nonhydrostatic and sub grid-scale nonlinear wave field, be parameterized into coupled hydrodynamic and water-quality models.

2B2.6

Biomass Burning and CO Abundance Seasonal Cycle: An analysis of MOPITT Data

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To isolate the effect of biomass burning on the atmospheric carbon monoxide (CO) seasonal cycle, we compare the global CO data from the Measurements Of Pollution In The Troposphere (MOPITT) with fire count data from the Along-Track Scanning Radiometer (ATSR). For the first year of MOPITT operation from March 2000 to February 2001, which was a relative normal year in terms of fire activities, we found that atmospheric CO loading was strongly influenced by biomass burning in South America, Africa, and Australia. It is observed that the peak of fire activities is usually 1-2 months earlier than the peak of CO loading in South America and Africa, but not in Australia. As for other regions, biomass burning does not appear to be a dominant factor in controlling the CO seasonal pattern. Taking zonal statistics, CO loading is shown to be correlated with fire counts for the northern tropical region (0-30° N) and Southern Hemisphere (0-30° S and 30-90° S), while for the mid and high latitudes in the Northern Hemisphere (30-90° N), the seasonal cycle of CO loading reflects the combined effect of atmospheric oxidation capacity, fossil fuel emission, and biomass burning. As a result, globally averaged CO loading shows a double-peak pattern, with one peak in April-May and the other in October-November. Fire emission in Southeast Asia contributes partly to the first peak, while the emission in Southern Hemisphere contributes significantly to the second peak. The normal seasonal CO cycle in a region can be perturbed or even reversed by anomalies of fire activities, as exemplified by the severe fires in Indonesia in 2002 and in Russia in 2002-2003. The CO annual cycle is further analyzed using a 3-D global chemical transport model, the GEOS-CHEM model with a long-term averaged inventory of biomass burning. The comparison between the MOPITT measurement and the output from GEOS-CHEM model will be presented.

4B1.3

Impact Of Parameter Representation In Gas-Particle Partitioning On Aerosol Yield Model Prediction

Janya Kelly [1] , Diane Michelangeli [2] , Paul Makar [3] , Janeen Casey [2] , Julie Bennett [2] , Don Hastie [2] , Michael Mozurkewich [2]
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A kinetic box model is presented highlighting the formation of secondary organic aerosol (SOA) from the photo-oxidation of toluene through a subset of the University of Leeds Master Chemical Mechanism (MCM) version 3.1, and a kinetically based gas-particle partitioning approach. The model provides a prediction of the total aerosol yield and a tentative speciation of aerosols initialized from experimental data from York University's indoor smog chamber. A series of model sensitivity experiments were performed to study the relative importance of different parameters in SOA formation. These include vapour pressure, NO_X conditions, mass transfer representation and wall reactions. Early sensitivity experiments indicate vapour pressure to be a critical parameter in the partitioning and final aerosol yield. Current estimation methods are highly sensitive to boiling point temperature and can lead to the propagation of errors in the model. Of concern is the estimation of vapour pressure for compounds containing organic nitrates (major contributors to the aerosol speciation). Current experimental conditions dictate a very high NO_X environment compared to other smog chamber studies, leading to the question of whether the model results arise from using different pathways in MCMv3.1 or from the physical representation of the partitioning in the model. Preliminary results show this is highly dependant on the aerosol species in question and the experimental conditions used. Sensitivity runs were also conducted to characterize the nature of the wall reactions occurring in the chamber and their impact on the NO_X budget in the model.

2C1.2 **INVITED / INVITÉ**

Data Assimilation and Stratospheric Science

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The goal of data assimilation is to combine measurements and models to "fill in" data gaps and provide a best estimate of the current state of the atmosphere. This estimate or "analysis" is most commonly used as an initial state for integrating a weather forecast model. Because the analysis provides a complete three-dimensional picture of dynamical and, more recently, chemical fields, it can also be used to gain insight into processes such as stratospheric sudden warmings or the ozone hole depletion. At the same time, such applications can highlight deficiencies of analyses and assimilation systems. The most obvious example of the feedback from climate science to data assimilation is the identification of transport errors of assimilated winds on the time scales of weeks to months and beyond. This talk will explore the role of data assimilation in stratospheric and mesospheric science.

3B3.8

Changes in the Southern Ocean as observed by Argo Floats

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In the past 5 years we have an unprecedented number of observations of the intermediate waters of the Southern Ocean as a result of the Argo float program. These data have not only allowed us to construct an accurate description of the Southern Oceans waters but also to compare the current state of the intermediate waters to the historical data. This comparison has revealed a dramatic warming and freshening of the intermediate waters in the subpolar region. This has changed the stratification of the region affecting the depth of intermediate waters and the path of the Antarctic Circumpolar Current. In this presentation we will discuss the details of the observed changes in the Southern Ocean and the implications for the dynamics and climate of the region.

3DPA5.8

A real-time atmospheric-oceanic-terrestrial diagnostic and prediction centre: The NOAA-UNH Joint Center for Ocean Observing Technology

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The newly-formed NOAA-UNH Joint Center for Ocean Observing Technology is a collaborative effort whose goal is to develop prototype analyses and predictions of the ocean, atmosphere and land spheres to enhance economic productivity and quality of life for both lay and advanced users. Products will be developed through the optimal fusion of advanced data assimilation, in-situ and remotely-sensed observations, and modelling techniques. Member organizations include NOAA, the University of New Hampshire (UNH), the Gulf of Maine Ocean Observing System (GoMOOS) and Atmospheric and Environmental Research, Inc. (AER). The centre's focus is the Gulf of Maine's 93,000 square kilometres of ocean, 12,500 kilometres of coastline and 180,000 square kilometres of watershed that are shared between three states and two provinces. Initial work implemented a real-time atmospheric prediction using the Penn State/NCAR atmospheric Mesoscale Model Version 5 (MM5) system in a triply-nested configuration centred over the southern half of the Gulf. A primary project goal is to collect and optimally assimilate in MM5 3d-VAR a diverse set of observations - currently upper-air; land and ocean surface reports; and QSCAT surface winds. Current real-time users include the US National Weather Service Forecast Office in Gray, Maine, and the UNH terrestrial water budget modelling community. Ongoing work involves implementation of the Advanced Research Weather Research and Forecast (ARW) model with improved characterization of the land-sea fluxes of heat and moisture. Ultimately the Center strives to be a data repository in which all manner of atmospheric and oceanographic environmental datasets will be available.

1DPA4.11
Resolving the Annular Modes

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A sector-EOF analysis applied to the extratropical tropospheric circulation extracts robust circulation patterns that represent the regional signature of the annular modes. These regional patterns are zonally localized, eastward-propagating, baroclinic-wave structures with the dipolar meridional structure of the annular modes. The regional patterns exhibit longrange correlations in longitude that may account for the annular modesÕ hemispheric scale.

2C3.4
Using the Weather Research and Forecast (WRF) Model for Estimating North America Carbon Fluxes

J. Eluszkiewicz [1], *T. Nehrkorn* [1], *J. Lin* [5], *C. Gerbig* [4], *S. Freitas* [3], *M. Longo* [2], *S. Wofsy* [2], *D. Matross* [2], *P. Mahadevan* [2]
(Presented by / Présenté par ***Janusz Eluszkiewicz***)
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A prototype data fusion and analysis system in which satellite, aircraft, and ground data are used to infer the magnitude of terrestrial carbon fluxes over North America on seasonal and inter-annual timescales is being developed. The system is based on a "receptor-oriented" analysis

framework that links concentrations at measurement locations to surface fluxes in upwind regions. The framework incorporates three main components: 1. The Stochastic Time-Inverted Lagrangian Transport (STILT) model, 2. An observation-based lateral boundary condition for CO_2, and 3. A parameterization for biosphere-atmosphere fluxes that uses observations from the AmeriFlux network.

The meteorological fields driving STILT are taken from runs with the Weather Research and Forecast (WRF) model. In this presentation we will describe the implementation of the WRF/STILT coupling, including a treatment of parameterized convective fluxes, and outline our plans for using this tool to infer North America carbon fluxes.

1DPA4.8

Wind-Generated Waves in Hurricane Juan

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We present numerical simulations of the ocean surface waves generated by Hurricane Juan (2003) as it reached its mature stage, travelling from deep waters off Bermuda to shallower coastal waters and making landfall at Halifax, Nova Scotia, using the WaveWatch3 (denoted WW3) and SWAN wave models implemented in nested grid domains. For Juan's rapid accelerating translation speed, a new interpolation method is proposed to accurately blend observed hurricane winds with numerical weather model winds. Comparisons of buoy data to model results suggest that WW3 tends to overestimate waves during the peak winds due to overestimation of the wind input energy, whereas SWAN tends to underestimate the highest waves due to its shallow water waves physics formulation, and problems with narrow band frequency and direction and long period swells. We show that wave intensity and composition, as well as variations in spectral and source term formulations for wind input and dissipation are highly dependent on Juan's wind intensity, translation speed and location. As Juan made landfall, maximum waves are mainly swell-dominated and occur in relatively low-wind regions of the hurricane.

1DPA1.6

High-Resolution Simulations of Orographically Enhanced Precipitation using a Multi-Moment Bulk Microphysics Scheme

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There have been considerable increases in the resolution of numerical weather prediction models around the world in the last few years. Consequently, bulk microphysics schemes (BMS), which compute the effects of cloud processes in saturated model grid boxes, are playing an increasingly important role. As we will show, the precipitation forecasts of high-resolution models can be very sensitive the details of the BMS. It is therefore becoming increasingly important for operational NWP to develop sophisticated yet efficient BMSs.

In this work, we continue to examine the utility of the multi-moment BMS developed by Milbrandt and Yau (2005a,b). During November-December 2001, the IMPROVE-2 experiment collected a comprehensive set of microphysical data over the Oregon Cascades with the objective of diagnosing and correcting problems associated with current BMSs. The experiment provides a useful data set for testing and calibrating the multi-moment scheme in the context of a case of

orographic precipitation. Simulations of the 13-14 December 2001 IMPROVE-2 case with the MC2 mesoscale model, at grid-spacings of 4 km and 1 km, have been performed using various versions of the scheme.

The full triple-moment version was successful at simulating the observed precipitation over a region of complex terrain. It will be shown that part of the skill of the scheme can be attributed to how the the ice-phase hydrometeor spectrum is partitioned into various categories. We will also examine the importance of the number of predicted moments of the particle size distributions for this case. This study aims at providing guidance for the development of BMSs for the next generation of high-resolution NWP models.

3DPA2.13

The All Weather Precipitation Gauge Algorithm for the Canadian Reference Climate and Surface Weather Networks

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The standardized all weather precipitation gauge algorithms for the Canadian Reference Climate and Surface Weather Networks are described. The new algorithms, developed at the Meteorological Service of Canada over the past two years, became necessary with the incorporation of the very sensitive Geonor weighing gauge into the Environment Canada RCS/Surface Weather network.

These algorithms apply to the datalogger or data collection platform and only extend to that processing necessary to provide quality 15 minute and hourly data output. The data input to these algorithms are minutely averages derived from five second samples.

Additional processing is performed outside the datalogger. Among other things, a final result will require a correction for the catch efficiency of the gauge, based on the wind speed and temperature measured at a 2 meter height. One such algorithm is presented here.

The data are from test sites at MSC's Centre for Atmospheric REsearch (CARE) at Egbert, Ontario, where manned data is also available and used as a reference. The manned data consists of all weather precipitation inside a DFIR, snow depth and temperature. As a result, although much simpler, the datalogger's snow depth and temperature algorithms are also presented.

3DPA4.3
Deriving agriculture-related climate extremes from GCM-simulated climate changes: an example using the AAFC-WG weather generator
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Stochastic weather generators are widely used for generating synthetic weather data, and constitute one of the techniques for developing local climate scenarios from GCM-simulated large-scale climate changes. Since impact models may be more sensitive to changes in climate extremes than to changes in climate means, it is important to evaluate the capability of stochastic weather generating techniques in reproducing climate extremes. An evaluation on the AAFC-WG weather generator is presented in this study, from the perspective of reproducing observed climate extremes. Extreme daily values were analysed on a monthly and annual basis as well as for the growing season (May 1st –September 30th), for several stations in Canada. Some indices relevant to extremes were also examined. Results showed that the AAFC-WG weather generator

could reproduce climate extremes reasonably well in the generated synthetic weather data. This presentation also provides a comparison of future scenarios of agriculture-related climate extremes in Canada under CO_2 doubling obtained, respectively, from direct daily GCM outputs and from the localized daily climate scenarios generated by AAFC-WG.

2B4.7

Reconstruction of daily soil moisture conditions using the Variable Infiltration Capacity model over China, 1971-2005

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Recent studies indicate that surface soil moisture may be as important as sea surface temperature as boundary conditions for the climate system. Although soil contains only a small fraction of the total available water in the world, the soil moisture condition plays a vital role in global water and energy exchanges. In this study, we use the Variable Infiltration Capacity (VIC) land surface macroscale hydrology model driven by observed maximum and minimum air temperatures and precipitation to map daily soil moisture values over China for the period January 1, 1971 to July 31, 2005. The model is applied over a grid of 10,458 points with a resolution of 30 km × 30 km. The model is first calibrated using observed hydrographs from 35 catchments with drainage areas varying from 190 to 351,530 km^2. The model is validated over these 35 catchments at different periods, and over another 8 with drainage areas ranging from 1,230 to 10,010 km^2. *In situ* soil moisture measurements from 28 sites over the country are also used for model validation. VIC performs well over both calibration and validation catchments especially in humid and semi-humid regions. The 35-yr soil moisture climatology for the top 1-m from VIC is consistent with known soil moisture conditions in China. VIC soil moisture is now used operationally for the calculation of a soil moisture index by the Chinese Ministry of Water Resources (CMWR), and nationwide maps of the index are published daily for drought monitoring.

1B1.7

A global inventory of stratospheric chlorine and fluorine in 2004 based on measurements by the ACE-FTS

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Total chlorine (Cl_{TOT}) and total fluorine (F_{TOT}) in the stratosphere have been determined using Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) measurements of HCl, HF, $ClONO_2$, COF_2, ClO, CCl_4, CF_4, CH_3Cl, CCl_3F, CCl_2F_2, $CHClF_2$, CCl_2FCClF_2, CH_3CClF_2 and SF_6, supplemented by data from other sources including both measurements and models for $CHClF_2$, ClO, ClOOCl, HOCl, COClF, $COCl_2$, CH_3CCl_3, COF_2 and many minor species. Chlorine and fluorine budgets were determined separately in five latitude ranges (60-82ºN, 30-60ºN, 30ºS-30ºN, 30-60ºS and 60-82ºS). The period of February 2004 - January 2005 inclusive was averaged when possible, to account for seasonal variations. Diurnal variation in the chlorine inventory was avoided by only using measurements taken at local sunset. Stratospheric Cl_{TOT} and F_{TOT} profiles are nearly linear in all five latitude regions. We obtained mean stratospheric Cl_{TOT} values of 3.62±0.10 ppbv for both the northern and southern midlatitudes independently, with a slightly lower value in the tropics and slightly higher values at high latitudes. Mean stratospheric F_{TOT} values range from 2.43±0.05 to 2.47±0.05 ppbv for each latitude region, with the highest value in the tropics. All Cl_{TOT} profiles had a slight positive slope, while F_{TOT} profiles typically had a slight negative slope in ppbv/km. We interpret both the observed slopes

and pattern of latitudinal variation as evidence of the beginning of a decline in global stratospheric chlorine and the continual increase in stratospheric fluorine.

1B1.6

Pressure and temperature profiles measured from space by the ACE-MAESTRO instrument

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The MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) space instrument was successfully launched on Canada's SCISAT satellite in August 2003, along with a Fourier Transform Spectrometer (the ACE-FTS), as part of the Atmospheric Chemistry Experiment (ACE) payload. MAESTRO is a UV-Visible-NIR dual grating spectrometer taking solar occultation and nadir backscatter spectra of the atmosphere to investigate the dynamical and chemical processes affecting stratospheric ozone distribution. On-orbit solar occultation measurements of temperature and pressure vertical profiles are desirable for accurate retrievals of aerosols and trace gas species from the instrument, as well as for incorporation into dynamical models of the atmosphere. Atmospheric density, pressure, and temperature can be determined by measuring the number density of a well-mixed gas with a known mixing ratio. Molecular oxygen is used for MAESTRO pressure and temperature retrievals as it is vertically well-mixed in the atmosphere and radiatively active in the instrument's spectral measurement range, with three strong absorption bands in the visible (gamma-band) and near-infrared (A- and B-bands). This paper discusses the challenges of correctly forward modelling the O_2 A- and B-bands for the low spectral resolution MAESTRO instrument, the retrieval algorithm for deriving pressure and temperature, and pressure and temperature profiles determined from data collected on-orbit. The profiles derived from MAESTRO are also compared with temperature and pressure profiles retrieved from the ACE-FTS instrument, which shares MAESTRO's line-of-sight, and coincident radiosonde measurements.

1C3.1 **INVITED / INVITÉ**

Vortical modes and gravity waves in rotating stratified turbulence

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Flows with stable density stratification such as (on average) the atmosphere and ocean can be decomposed into vortical motion (with potential vorticity) and internal gravity waves. Vortical motion dominates at large quasi-geostrophic scales, but moving downscale into the atmospheric mesoscale and oceanic submesoscale, Coriolis effects weaken and vortical and wave motion coexist. We will present simulations of homogeneous turbulence in this strongly stratified, weakly rotating regime in a uniformly stratified Boussinesq fluid with a linear vortical--wave mode decomposition. We will focus on the energy spectra and characteristic vertical scales, show how these quantities vary with stratification and rotation, and compare our results with observations and theoretical predictions. Vortical and wave modes yield very different energy spectra, and nonlinear interactions between the two types of modes are shown to have a significant effect on the shape of the wave energy spectrum. The characteristic vertical scale of vortical motion transitions from $(f/N)L$ to U/N as the Rossby number increases beyond $O(1)$, in line with various theories (here f is the Coriolis parameter, N is the Brunt-Väisälä frequency, L is the horizontal scale, and U is the r.m.s. velocity). Implications for more realistic atmosphere and ocean models will also be discussed.

4C1.3

Evaluation of a five year global simulation with GEM-AQ

Lori Neary [1] *, J.W. Kaminski* [1] *, J.C. McConnell* [1] *, A. Lupu* [1] *, J. Jiang* [3] *, M. Filipiak* [2]
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Evaluation of a Five Year Global Simulation with GEM-AQ L. Neary, J. Kaminski, J.C. McConnell, A. Lupu, York University, Toronto J. Jiang, Jet Propulsion Lab, California Institute of Technology, Pasadena, USA M. Filipiak, School of GeoSciences, University of Edinburgh
The Global Environmental Multiscale model with air quality processes (GEM-AQ) has been developed by the Multiscale Air Quality Modelling Network (MAQNet). The model is based on the Canadian operational weather prediction model (GEM) and includes online chemical processes for 53 gas phase species and 4 size-resolved aerosol types. For this work, the model was run with a globally uniform resolution of 1.8x1.8 degrees and 28 vertical levels. To examine seasonal variations and regional distributions of ozone, results from a five year simulation will be presented and compared with monthly mean ozonesonde data and 2D climatology (Logan et al., 1999). Ozone precursor climatologies compiled by Emmons et al. (2000) also provide a useful means to identify issues relating to the processes and emissions used in the model. In addition to these surface-based observations, space-borne instruments such as MLS and OMI onboard the AURA satellite and MOPITT on the TERRA satellite can supply measurements for model evaluation. In addition to the above, a comparison of modelled and measured CO will be presented.

4B3.1 **INVITED / INVITÉ**

Air-sea exchange of gases and particles: Their roles in ocean biogeochemistry, atmospheric chemistry and climate

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SOLAS (Surface Ocean – Lower Atmosphere Study) is an international programme to study the interaction between the oceans and the atmosphere as a coupled biogeochemical system. More than 20 nations are participating to the programme, of which the contribution of Canadian-SOLAS (C-SOLAS) is exceptional both in terms of scientific results (which are the main subject of this session), as well as being the first major funded national effort in the SOLAS programme.

In this talk I will review some of the exciting results which are being achieved in SOLAS internationally, with particular reference to the contributions of C-SOLAS. I will also discuss some educational achievements, for example the 2 SOLAS summer schools held to date, as well as discussing directions the programme will take in the future.

1DPA4.14

Analysis of Hurricane Generated Waves using a Moving Grid Reference System

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In order to simulate waves within or near a hurricane with high spatial resolution, a moving grid version of the operational NCEP WaveWatch3 (WW3) model is tested and developed. For a cyclone moving with translation speed v (homogeneous in space varying in time), group speed for propagation is shifted; $c_g - v$. If we consider Cartesian coordinates, deep water waves, without bathymetry changes, coastline or islands, the energy balance equation can be simplified, in a moving grid reference system. The advantage of a moving grid reference system waves is that much finer spatial resolution is possible, because the required computational domain is smaller,

and the run time is much less, compared to traditional model implementations. In this study, both traditional and moving grid WW3 models are applied to waves generated by hurricane Juan.

There are a number of issues related to moving grids. It is important to properly specify swell, as generated from more remote portions of the stationary large scale domain, passing into the moving grid, sub-nest. Failure to properly account for swell, and recently generated wave energy results in significant biases in the estimated waves in the moving grid domain, and spurious asymmetric features. A critical factor is the propagation speed of the hurricane. In Juan's early stages, when it is propagating at ~ 2 m/s, the moving grid and traditional stationary computational grid both verify well, compared to observations. However, as Juan enters its extratropical stage, its propagation speed accelerates. This feature is unique to extratropical storms, as tropical hurricanes tend to maintain slow propagation speeds. At ~ 8 m/s, Juan's propagation speed approximates the group speed of the dominant wave. In this circumstance, the energy pumped into the waves can become very large, and the moving grid estimates for wave heights can exceed the stationary grid estimates by up to 40%. At even higher propagation speeds, as Juan approaches 16 m/s the moving grid estimate for maximum wave heights tends to suggest underestimates by as much as 20%. Attention to the actual wave field of the spatially changed area under different driven wind and incoming swell, and excessive swell blocked within moving grid domain can solve these problems.

3B1.3

Lunar and solar FTIR Nitric acid measurements at Eureka in winter 2001/2002: Comparisons with observations at Thule and Kiruna and with CMAM and SLIMCAT model calculations

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For the first time, vertical column measurements of HNO_3 above the Arctic Stratospheric Ozone Observatory (AStrO) at Eureka, Nunavut (80N, 86W), have been made during polar night using lunar atmospheric absorption spectra recorded with a Fourier Transform Infrared (FTIR) spectrometer, from October 2001 to March 2002. This was accomplished by means of a modified solar tracking system with increased light sensitivity capable of tracking the Moon as the light source. AStrO is part of the primary Arctic station of the Network for the Detection of Stratospheric Change (NDSC) and these measurements were compared with FTIR measurements at two other NDSC Arctic sites: Thule, Greenland (76.5N, 68.8W) and Kiruna, Sweden (67.8N, 20.4E). The measurements were also compared with two atmospheric models: the Canadian Middle Atmosphere Model (CMAM), a free-running Chemistry-Climate Model, and with SLIMCAT, an offline 3D Chemical Transport Model driven by analysed winds and temperature. Here we present the first intercomparison of HNO_3 columns measured at the three NDSC Arctic sites, Eureka, Thule and Kiruna, together with the first comparison of the CMAM chemical fields with observations in the polar regions, at Eureka and Kiruna. The 2001/02 winter was relatively warm, with two major stratospheric warmings occurring in December 2001 and February 2002 and with the daily average area for PSCs of near zero throughout the winter. Thus the meteorological conditions provide an excellent opportunity to compare and test the CMAM version 7 warm climate against observations to assess the seasonal increase of HNO_3 under PSC-free conditions.

2DPA5.8

Coupled simulation of water and carbon cycles at regional scales

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Water and carbon (C) cycles interact at various temporal and spatial scales. To improve carbon balance estimation for Canada's forests and wetlands, a three-dimensional hydrological model was developed and integrated into the Integrated Terrestrial Ecosystem Carbon (InTEC) model to describe the effects of soil water on photosynthesis and soil C decomposition. In this hydrological model, the influences of topography and drainage conditions on soil water horizontal redistribution are explicitly described. The vertical movement of water between soil layers is quantified through implicitly solving Darcy's equation. Calibrated with soil moisture measurements at tower sites of Fluxnet Canada and streamflow data at in 80 non-regulated river basins, this model is able to capture seasonal and interannual variations in soil moisture and stream flow with reasonable accuracies. The inclusion of lateral flows is important for the successful soil water simulations.

Model results show that in the last century, water balance in Canada's forests and wetlands responded closely to climate variability. Changes in soil water content were not spatially and temporally homogenous. During three warm and dry periods of 1910's, 1940's, and 1980's to 1900's, annual mean streamflows decreased, especially in the southern part of Canada. Drying of soils during these periods reduced photosynthesis and enhanced heterotrophic respiration, causing reductions in net C uptake. In eastern Ontario and western Quebec, temperature decreases and precipitation increase resulted in increases in streamflows and soil wetness. These areas were C sinks, absorbing 50 to 150 g C m^{-2} yr^{-1} in 1990s.

3DPA2.8

First detection of meso-thermospheric Nitric Oxide (NO) by ground-based FTIR solar absorption spectroscopy

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We report the first detection of mesospheric-lower thermospheric (MLT, 50-130 km) NO from ground-based FTIR solar absorption spectra using Lorentz and Doppler-broadened solar absorption lines in the stratosphere and in the MLT, respectively. We present the first characterization of vertical sensitivity in the FTIR NO retrieval and show that MLT NO partial columns can be retrieved with ~ 1 independent piece of information using a climatological NO profile extending up to 130 km. The information content analysis also improves the characterization of stratospheric partial column retrievals and is relevant to NO results obtained at other Network for the Detection of Stratospheric Change (NDSC) FTIR sites. We apply our approach to spectra recorded at Complementary NDSC site Toronto (43.66 N, 79.40 W) during the solar storms of Oct-Nov 2003 and at Primary NDSC site Eureka (80.05 N,86.42 W) during Feb-Mar 2004. MLT NO enhancements are found at Eureka, while possible enhancements at Toronto cannot be attributed to a particular altitude.

3DPA1.3

Sensitivity of the CRCM hydrological cycle to the land surface processes formulation

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Climate models require the fluxes of radiation, momentum, sensible and latent heat across the soil-vegetation-atmosphere interface. These fluxes are provided by land surface parameterization schemes. The appropriate level of complexity of land-surface schemes for use in climate models is still an unresolved issue. Simple, Manabe-based parameterizations of land surface processes, as well as very complex formulations, where exchange between the atmosphere and the land surface is controlled by plant physiology, continue to coexist.

Numerous investigations performed with different climate models have shown that the simulated climate is sensitive to the formulation of land surface processes. The present study investigates sensitivity of the hydrological cycle simulated by the Canadian Regional Climate Model (CRCM) to the formulation of land surface processes. In addition, we evaluate the CRCM ability to simulate all water cycle components using an integrative approach (Music and Caya, 2004). Two different simulations performed with the CRCM over North America for the period 1959-1999 are analysed. In the first simulation, the Manabe-based formulation of the land surface processes is used, while in the second-one, the CRCM is coupled to a more sophisticated land-surface scheme (CLASS). The results show that the simulated hydrological cycle is sensitive to the choice of the land surface scheme and is more realistic when CLASS is used.

4DPA6.16

Pollutants over the southern Strait of Georgia: Analysis of CRUISER measurements made on Saturna Island.

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Complex meteorology influenced by mountainous terrain and land-sea contrasts makes air quality within the Georgia Basin of SW British Colombia a complex issue. During more-stagnant periods, emissions from urban, industrial and marine vessels, accumulate and are acted upon by the local meteorology. Previous research (Brook et al., 2004) has indicated that the southern part of the Strait of Georgia can play an important role in the accumulation, atmospheric chemistry and re-distribution of pollutants. To better understand these processes and the impact of local and regional emission sources influencing this area, Environment Canada's mobile lab, CRUISER, was located on the sparsely populated Satruna Island during the spring and summer of 2005.

Background concentrations of gaseous and particulate concentrations at Saturna were representative of a remote site. In addition, periods of relatively high SO2, NOy and particle concentrations, indicative of more polluted air masses were observed. These episodes were of varying duration and chemical composition, implying that the site was impacted by a variety of emission sources, both local and regional. While some of the episodes had the signature of combustion sources, others did not. Additionally, the age of the airmass was observed to vary providing insight into the chemical processes influencing air pollutants over the Strait. Using our measurements, other supporting measurements and information, as well as the National Pollution Release Inventory data (NPRI) a concerted effort is made to characterize these events in the effort to assign appropriate sources and identify the main processes influencing concentrations and composition.

2C3.5

Modeling the carbon and hydrological cycles in a black spruce-moss dominated ecosystem in boreal eastern Canada.

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Hydrological controls on carbon cycles of terrestrial ecosystems have been well recognized. Modeling of carbon flows as well as hydrology at a watershed scale was attempted for a Black Spruce-Moss dominated ecosystem in a boreal landscape near Chibougamau, Quebec. The BEPS-Terrainlab model was run over this landscape for 2004. Explicit spatial datasets for landcover, soil texture, elevation, slope, and aspect as well as LAI were used in addition to meteorological datasets. The results showed clear spatio-temporal variations in carbon fluxes (GPP and NPP) as well as hydrological components (ET and water table). There was a close connection between the landcover type and spatio-temporal magnitudes of carbon and water fluxes. Mixed forests showed the highest NPP and GPP as well as the highest ET, while wetlands showed the lowest. Pure Black Spruce stands showed intermediate values. The average simulated values over the footprint area of an eddy covariance tower at the Eastern Old Black spruce site of the Fluxnet Canada Research Network are compared with the measured fluxes. The r2 values of 0.84and 0.56 were achieved for GPP and ET, respectively. Both "big-leaf" as well as "two-leaf" approaches were used to simulate ET, and the "two leaf" approach was found to be more accurate than the "big-leaf" approach although the accuracy was highly dependent on landcover. Components like moss-peat mediated vertical water flows might complicate landscape hydrological processes in boreal areas; hence their explicit description is imperative for future research.

4B4.6
Changes to ENSO under CO2 doubling in the IPCC AR4 multi-model ensemble
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In 2004-05, output from nearly two dozen coupled climate models was assembled for analysis by hundreds of climate scientists worldwide, in large part to provide input for the IPCC Fourth Assessment Report to be completed in 2007. This talk describes results from one such analysis whose aim was to quantify projected changes in ENSO amplitude, period, and pattern resulting from increased greenhouse gas concentrations. ENSO properties under pre-industrial control conditions and for the first century following stabilization at twice pre-industrial CO_2 concentrations were compared. The significance of these differences was assessed in terms of century-to-century differences within the control run. Under pre-industrial conditions, modeled ENSO amplitudes (defined as the rms of the first principal component of near-equatorial Pacific SST) and periods, while differing among the 15 models considered, are roughly centered about observed present-day values. However, under CO_2 doubling 3 of the models show significant (p<0.1) ENSO amplitude increases, whereas 5 show significant decreases. Although the reasons for these varying responses are not clear, models that exhibit amplitude decreases tend to have ENSO-correlated zonal wind stress anomalies that are too equatorially confined, whereas for models that exhibit amplitude increases these anomalies are more realistically broad. Overall the ensemble exhibits an ENSO period decrease of ~5%, comparable in magnitude to projected increases in the propagation speeds of equatorial waves that can influence ENSO timescale through delayed feedbacks.

1DPA2.17
Estimation of spatially explicit understory and overstory leaf area index for peatlands using a geometric optical transfer model and spectral mixture analysis
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Peatlands have generally been ignored in many modelling efforts at the watershed scale, mainly due to the incomplete understanding of peatlands' complex hydrology, which is influenced by their climatic, topographic, and (hydro) geologic settings. Distributed, process-oriented ecosystem

models such as the Boreal Ecosystem Productivity Simulator (BEPS) can be considered as promising tools to further the understanding of the complex hydrology of peatlands and to quantify possible responses of peatland carbon dynamics to likely climatic changes. One of the most important input parameters for the application of BEPS is spatially explicit leaf area index (LAI). LAI is a dimensionless quantity of the amount of foliage area per unit ground surface area. It characterizes the canopy-atmosphere interface of an ecosystem, and is thus related to canopy microclimate, precipitation interception, radiation extinction, and water, carbon, nutrient, and energy exchange. Traditionally, spatial distributions of LAI have been estimated from the relationship between various vegetation indices (VI) derived from remote sensing data and LAI field measurements. The vegetation structure of peatlands, often characterized by the abundance of shrubs and mosses and patches of open tree canopies, clearly limits the applicability of traditional VI-based approaches due to sub-pixel scale background reflectance. The objective of this contribution is to demonstrate the potential of the integrated use of field-based LAI and spectral reflectance measurements in combination with a geometric optical radiative transfer model and spectral mixture analysis for the estimation of spatial LAI distributions for the shrub and tree canopies of Mer Bleue, a raised bog located near Ottawa, Ontario.

2C4.7
On the Nature of Zonal Jet EOFs
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Basic structures of midlatitude atmospheric Low-Frequency Variability (LFV) are generally obtained using multivariate statistical techniques such as Empirical Orthogonal Function (EOF) analysis, which considers the eigenstructure of the covariance matrix of atmospheric states. Often, individual PCA basis functions are taken to represent distinct physical "modes" of variability. In this talk, we will develop analytic expressions for the covariance structure of an idealised midlatitude jet that can vary in strength, width, and position. Through a systematic perturbation analysis, we can read off the leading few EOF modes of the system. This analysis demonstrates that many of the assumptions commonly made in interpreting EOF structures hold only in limited parameter ranges. In particular: (1) the EOF time series are generally uncorrelated, but not independent, (2) individual EOF "modes" do not generally represent individual physical processes, and (3) EOF structures arising due to individual processes alone can be mixed, or "hybridised", when these processes occur simultaneously.

4C3.3
Canadian SOLAS studies of methyl halides in the NE Pacific and NW Atlantic
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The Canadian SOLAS iron fertilization experiment in the NE Pacific demonstrated that although phytoplankton species abundance and composition were markedly affected by iron addition there was no significant influence on the concentrations of methyl halides or their fluxes into the atmosphere. The study region was a moderately strong source of methyl iodide to the atmosphere.

Three NW Atlantic cruises provided strong evidence for seasonality in the concentrations, fluxes and production rates of methyl halides, especially methyl iodide, with the highest surface concentrations occurring in summer and the lowest in spring for most stations. The higher concentrations tended to be associated with warmer waters. In view of literature evidence for both algal and photochemical sources of CH_3I, the data were examined to determine whether either source was supported.

Methyl iodide was not correlated to total algal biomass, nor were there good correlations with abundances of phytoplankton subgroups as defined by pigment concentrations. There was support for the influence of solar radiation on CH_3I production, but the influence could occur through biology or photochemistry. The results tend to support the existence of multiple mechanisms operating simultaneously.

Empirical relationships (e.g. between CH_3Cl and T) offer means of extrapolating limited data sets to yield global estimates of methyl halide fluxes into the atmosphere. Nevertheless, the apparent complexity of the source processes and the absence of defined mechanisms renders it impossible at present to reliably predict the influence of climate change on the fluxes of halogens into the atmosphere carried by these compounds.

2DPA5.2

Response of the Global Carbon Cycle to Climate Based on Monthly CO2 Flux Inversion from 1994 to 2004

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Various inverse techniques are currently available for estimating global and regional carbon fluxes using atmospheric CO_2 concentration observations. However, the number of currently inverted regions is still very limited due to sparse atmospheric measurement sites and computational limitations. In this study, a nested inverse modeling system has been developed for estimating carbon fluxes of 50 regions globally including 30 regions in North America. Global inversion based on the Bayesian principle is conducted in monthly steps for the period from 1994 to 2004, using CO_2 concentration measurements at 95 atmospheric stations. A set of response functions, describing the response of each station to fluxes from each region at monthly time steps over the 11 years, have been produced using the NIES model coupled with an ecosystem model Biome-BGC. NIES is a global transport atmospheric model developed at the National Institute of Environmental Studies in Japan. Preliminary inversion results of carbon fluxes of these 50 regions have been obtained. Combining the results with changes in the observed climate during the study period, we can obtain some insight into the environmental processes that have influenced the variations in the carbon flux in all regions in the globe. The nested inversion results also allow us to study the spatiotemporal carbon dynamics in North America in comparison with previous biospheric modeling results based on remote sensing.

4C3.4

Latitudinal distributions of DMSP and DMS in the NW Atlantic in two years (1999 and 2003)

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During the Canadian Atlantic SOLAS year (2003), DMSP and DMS were measured in profiles at 8 fixed stations and by continuous pump surface sampling during three seasonal periods : April-May, July and October. The stations ranged in latitude from 36.8 °N to 59.6 °N and included representatives of six marine biogeographic provinces. This is the first large-scale, multi-season study of DMSP and DMS measurements in the Northwest Atlantic. In addition, a previous expedition in September 1999 followed a similar cruise track (38.0 °N to 61.4 °N) and employed similar sampling protocols, providing a fourth point of comparison. Except in the far north of the study area, September 1999 was exceptionally warm compared to the other sampling periods, while phytoplankton biomass was generally low. Peak DMS and DMSP concentrations were observed in the southern half of the study area (<50 °N) in April-May 2003 and in the northern

half (>50 °N) in July 2003, indicating a northwards progression of the zone of highest DMS(P) productivity, which parallels the progression of the phytoplankton bloom season. By contrast, in September (1999) and October (2003), DMS(P) concentrations had fallen by an order of magnitude. Overall DMSP concentrations correlated with the observed abundance of known DMSP-producing phytoplankton species (dinoflagellates, chrysophytes, coccolithophorids and other prymnesiophytes). DMS concentrations showed weaker correlation with phytoplankton abundance, reflecting the secondary influence of microbial community structure on the conversion of DMSP to DMS.

3C1.7

Using GPS-derived estimates of Precipitable Water to Identify Thunderstorm Signatures

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High temporal estimates of integrated precipitable water vapour (PWV) can be derived from Global Positioning System (GPS) signals due to refraction of the signal caused by water molecules in the atmosphere. The resulting error in GPS signal length from the refraction can be translated into PWV. If observations are available from a network of ground-based GPS reference stations, high temporal and spatial resolution of atmospheric moisture may be achieved in near real-time. Over one thousand GPS reference stations are operated worldwide, with many countries routinely making use of such data in numerical weather predictions and climate studies. In this paper, we study data from the Southern Alberta Network (SAN) of up to ten GPS receivers operated by the University of Calgary during the summers of 2003 and 2004. These data were examined as part of the Alberta GPS Atmospheric Moisture Evaluation (AGAME) campaign. Signatures associated with development of thunderstorms and other severe weather are identified, and limitations in current numerical weather predictions are assessed for the southern Alberta region. The applicability of examining hourly trends of PWV to demonstrate moisture convergence and the use of this novel data source as an aid in the prediction and nowcasting of thunderstorms is explored.

2DPA6.3

Migrating and Non-migrating Tides Simulated by the extended Canadian Middle Atmosphere Model (CMAM)

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A rich spectrum of tides (migrating and non-migrating) is generated in the extended Canadian Middle Atmosphere model. These waves have temperature amplitudes ~ 1K in the upper stratosphere and grow with height. They dominate the dynamics of the upper mesosphere and lower thermosphere (temperature amplitudes 10 ~30K). Amplitudes and phases in temperature, zonal, meridional wind and geopotential height associated with have been diagnosed from one year of a four year model run for diurnal, semi-diurnal and terdiurnal components with zonal wavenumbers 0 to 5. While the well known migrating diurnal tide has the strongest amplitude, other components are also significant. For most components there are episodic enhancements in the amplitudes and changes in their latitudinal structure. Annual and semi-annual variations in the amplitudes are also observed. A selection of the large amplitudes tidal features is presented in this talk. The model tides compare favorably to published observations.

4DPA6.30

Development of An Automated Measurement System Using An Online DNPH Cartridge and High-Performance Liquid Chromatography for the Continuous Monitoring of Gaseous Carbonyls in Ambient Air

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Organic carbonyls are present in the atmosphere through primary emission from anthropogenic and biogenic sources, and from secondary photochemical oxidation of volatile organic compounds (VOCs). The toxicity of some low molecular carbonyls and high level of organic carbonyls during smog events are serious concerns in atmospheric chemistry. Also, it has recently been shown that heterogeneous reactions of carbonyls in aerosols to form polymers can contribute to the organic content of atmospheric particulates. An automated measurement system for continuous monitoring air borne carbonyl compounds by using online sampling cartridge in combination with commercial HPLC was developed. With this automated measurement system, the sample collection, carbonyl compounds derivatization and extraction can be integrated with the sample analysis step, which eliminates a manual sample preparation step. Low molecular weight carbonyl compounds such as formaldehyde, acetaldehyde, acetone, propionaldehyde, butyraldehyde and others are effectively collected by the online cartridge and derivatized completely to respective hydrazones by 2,4-dinitrophenylhydrazone (DNPH) before injection into the HPLC system. A programmable controller sequences all measurement operations and an automated continuous measurement can be performed at 2hours intervals. The optimum conditions for the system will be described and the measurement results of air borne carbonyl in York University campus will be presented.

3C3.2
Observations of Antarctic Intermediate Water Formation in the Pacific
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Antarctic Intermediate Water (AAIW) forms the largest body of intermediate water in the Southern Pacific. AAIW is distinguished by a salinity minimum in the vertical profile. As such, it has been theorized that AAIW must originate near the northern boundary of the Antarctic Circumpolar Current where surface waters share a similar density and salinity. However, due to a lack of observations there have been several theories about the formation of AAIW. The Argo Float program has provided the observations necessary to describe the details of AAIW formation and its path into the subpolar gyre of the South Pacific.

1DPA2.20
A Comparative Stratospheric Retrieval Using Optimal Estimation and Nonlinear Optimization
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The Optimal estimation dominates in the retrieval of atmospheric remote sensing measurements, where a priori information about the atmospheric state is encapsulated in the form of probability distributions, which are independent of the observed data. When such distributions are combined with probabilistic information about data uncertainties, it is possible to derive a final (a posteriori) probability distribution assimilating both types of information.

However, the construction of a priori probability distribution is a controversial matter when statistical information about the atmospheric variability is unknown. In addition, the optimal estimation method is good for information content and error analysis, but fails for even moderately nonlinear problems. Most atmospheric trace gases profile retrievals are moderately nonlinear problems.

An alternative approached is to use nonlinear optimization. We have used a simple and efficient nonlinear optimizations namely the sparse nonlinear least square method (SNLS). It is based on regularized Gauss-Newton method including upper and lower bound constraints. The regularization matrix (L) has been built using a covariance matrix as $L^tL=B^{-1}$. A complete retrieval scheme is developed using nonlinear optimization as well as optimal estimation for balloon based occultation spectroscopic measurements. The limitations of the optimal estimation and the advantages of nonlinear optimization retrievals will be discussed. Nonlinear optimization is used to retrieve the vertical profile from 16km to 45km of the trace gases (O3, NO2, CH4 etc.) with vertical resolution of 1km and error of 3-5% from a set of balloon based occultation measurements.

4DPA7.11
Evaluation of an Adaptive Plankton-DOM Model in the North Atlantic
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Marine dissolved organic matter could potentially affect the air-sea flux of CO2 strongly both short and long term, via exchange with dissolved inorganic carbon (DIC). We employ a plankton model whose adaptive formulation of bacteria-DOM interactions is specifically geared towards understanding the formation, accumulation and eventual mineralization to DIC of refractory DOM. Our strategy of explicitly modelling DOM lability (bioavailability) is less tunable but more informative than specifying the time scales of bacterial utilization of individual DOM fractions, and offers the potential for examining long-term effects, e.g., of changing temperature or ocean stratification, on DOM cycling. The model is tested against data at two contrasting sites in the North Atlantic, the Labrador Sea and BATS. The model produces a reasonable seasonal cycle at both sites. DOM accumulates too much over the long term at BATS, indicating the need to include UV photochemistry in the model.

1B4.4

Sensitivity of an arctic regional climate model to the horizontal resolution during winter: Implications for aerosol simulation.

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Our ability to properly simulate current climate and its future change depends upon the exactitude of the physical processes that are parameterized on the one hand, and on model configuration on the other hand. In this paper, we focus on the latter and investigate the effect of the horizontal grid resolution on the simulation of a month of January over the Arctic. A particular attention is given to the effects that horizontal resolution has on the aerosol transport and cloud radiative forcing. A limited-area climate model is used to perform simulations over a grid that includes the Arctic and sub-Arctic regions. 2 horizontal resolutions are compared: 100 km and 50 km. Results show that increasing horizontal resolution increases the realism of the simulation over surface heterogeneities as expected. In addition, increasing horizontal resolution has a significant impact on other areas (with homogeneous surface) through feedback processes,

which arises from the interaction between temperature change in sub arctic regions, which results from increasing resolutions over surface discontinuities), and large-scale circulation.

1B3.2
Dynamics of the Antarctic Circumpolar Current in the Pacific
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The Antarctic Circumpolar Current (ACC) is an essential component of the ocean circulation. Its dynamics involve an interesting combination of channel flow and Sverdrup dynamics as the momentum balance involves wind stress, eddy form stress and topographic form stress. In this talk, we discuss the path and strength of the ACC in the Pacific and, in particular, as it enters the Drake Passage. Both theoretical models and numerical simulations will be discussed.

1DPA1.23
The Research Support Desk (RSD) initiative at Environment Canada: recent results and future plans
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National laboratories are being implemented at Environment Canada Storm Prediction Centres (SPCs) across Canada with the goal of enhancing technology and knowledge transfer between the operational and research communities. The Research Support Desk (RSD) initiative aims to further facilitate technology and knowledge transfer by allowing forecasters and researchers to work side-by-side in real-time during high-impact weather events. In this way, forecasters are exposed to new techniques, tools and data while researchers are able to apply their scientific work in real-time and identify 'science gaps' in operational offices.

During the summers of 2004 and 2005, an RSD was implemented in the operations area of the Ontario SPC. The scientific focus was on mesoscale analysis and nowcasting of summer severe weather using Environment Canada's object-oriented prototype nowcasting platform, Aurora. Mesoprognosis and hourly mesoanalysis products were introduced to assist with convective nowcasting. Post-season surveys show that forecasters have become increasingly comfortable with a research presence in the operational area, perceive significant benefits to the operational program, and have a strong interest in seeing the initiative continued into the future.

A winter version of the RSD has undergone more limited testing at the Ontario SPC. The focus there has been mainly on the use of dual-polarization radar data for the identification of rain/snow boundaries.

Based on the success of the RSD at the Ontario SPC, RSDs are being planned for each of the SPCs across Canada. RSD plans for 2006, at the Ontario SPC and at other SPCs, will be discussed at the Congress.

1B1.3

The Future of Carbon Monoxide Measurements from Space

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The Measurements Of Pollution In The Troposphere (MOPITT) instrument has been in orbit for over six years and has now been joined by other satellite instruments measuring carbon monoxide (CO). The proven utility of such measurements has encouraged us, with the support of the Canadian Space Agency to consider the possibility of a successor instrument in the 2010+ time frame.

The demands on such instrumentation are many: coverage, resolution, accuracy and in addition the operational constraints can be significant. This lead to a consideration of the opportunities and limitations of such measurements from space and these need to be fully understood in order to provide and effective compromise between the desires of modellers, the abilities of the instrument scientists and the constraints of launches, spacecraft and budgets.

This presentation will attempt to outline some of these issues and provide some framework for discussing what instrumentation could be deployed in the foreseeable future (next 10-20 years). The major items to be addressed are: Vertical, Spatial and Temporal resolution, Coverage, Revisit Time, Accuracy/Precision and desired contemporaneous measurements. All of these exist in a "trade space" in which emphasising one parameter will probably compromise another. Using what we have learned from the current MOPITT, we can intelligently guide all the various parts of the project: instrumentation, modelling and validation.

1B3.6
Models of the Probability Distribution of Sea-Surface Wind Speeds
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Models of the Probability Distribution of Sea-Surface Wind Speeds Models of the probability distribution of sea-surface wind speeds are important for the estimation of space/time averaged air-sea fluxes in both diagnostic and modelling studies. This talk will discuss the physical origin of the observed wind speed distributions, as well as efforts to develop quantitatively accurate models of these distributions. Particular emphasis will be placed on the importance of understanding the probability distributions of the vector winds, and the relationships between moments of the vector winds that are imposed by boundary-layer dynamics.

4DPA7.8
Diatoms as a source of DMSP in the Hudson Bay region
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Dimethylsulfoniopropionate (DMSP) plays a key role as precursor of the climate-active gas dimethylsulfide (DMS) and as a large source of carbon and sulfur for marine bacteria. DMSP is produced by marine phytoplankton and its concentration is highly taxon-specific, varying strongly in time and space. In 2004 and 2005, the distribution of DMSP was investigated for the first time

in Hudson Bay, Foxe Basin and the Hudson Strait, during the MERICA missions (Mers Intérieures du Canada). In both years, the highest DMSP concentrations were observed in Hudson Strait, where the highest chlorophyll *a* (Chl *a*) values were also found. In 2004, the phytoplankton assemblage (sampled at the Chl a maximum) was dominated by diatoms at the majority of stations. Both DMSP and Chl *a* were well-correlated with diatom abundance. No other taxonomic groups showed significant correlation with either DMSP or Chl *a*, suggesting that diatoms were likely the principal source of DMSP. This supports previous observations in subarctic and arctic regions, where the relationship between ice diatoms and DMSP was highlighted. While in temperate areas, pelagic diatoms are not generally observed to produce large amounts of DMSP, they may do so in subarctic regions where DMSP may act as a cryo-protectant. Climate change could significantly alter the pattern of DMSP production in northern regions, as species assemblages change in response to oceanographic conditions. This would have an unknown feedback effect on global climate via DMS emissions to the atmosphere.

2DPA6.14

Four Years of Stratospheric Composition Measurements in the Canadian High Arctic and Comparison with Atmospheric Models Chemical Fields

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In the Arctic, the ozone column shows high inter-annual variability, with low values during cold winters when stratospheric temperatures are low and the vortex breakup occurs late in spring, and high ozone values during warmer winters with higher stratospheric temperatures and disturbed vortex conditions. Although the fundamental mechanism for polar ozone depletion is generally understood, the Arctic ozone depletion process is complicated by the strong coupling between transport, heterogeneous chemistry, and halogen activation. To contribute to our understanding of the processes determining the Arctic stratospheric ozone budget a UV-visible spectrometer has been deployed at the Environment Canada's Arctic Stratospheric Ozone Observatory (AStrO) located at Eureka, Nunavut (80N, 86W). For four years, ozone and other key trace gases (primarily NO_2 columns and profiles) have been measured at the time of year when the conditions leading to polar ozone depletion develop. These measurements were combined with those made by the infrared Fourier transform spectrometer at AStrO which measures the total columns of several stratospheric gases (primarily ozone, HF, N_2O, HNO_3, NO_2, NO, CH_4, HCl, and $ClONO_2$) to assess the chemical fields generated by atmospheric models. Here, we present the comparison of the observational data set with chemical fields from the Canadian Middle Atmosphere Model (CMAM), a free-running General Circulation Model, during four Arctic winters of 1999, 2000, 2001 and 2003. We look at the observed and modeled variability of several stratospheric gases together with dynamical variables such as potential vorticity to examine the physical processes which caused the variability.

2DPA5.10

Forest stand age as a possible cause for variability of Jmax and Vcmax model parameters

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Measurements of foliar net carbon exchange provide crucial parameters for terrestrial carbon cycling models: e.g. RUBISCO-regeneration efficiency, Jmax, and carboxylation efficiency, Vcmax. Modelers often treat these parameters as constants. However, recent research has shown that these parameters may vary with tree age and seasons. We have measured photosynthetic capacity of trees across a chronosequence of four, temperate, white pine, plantation forests in Ontario, Canada (66, 31, 16 and 3 years of age). These sites are known as the *Turkey Point Flux Station (TPFS)*. Our initial results show that Jmax and Vcmax do vary

among the four different-aged forest stands, suggesting that stand age may be an important factor to consider when modeling annual course of terrestrial carbon cycling across regions, such as North America. However, stand history and micro-climate differences may also cause these parameters to vary, overshadowing any age-related controls. There is an increasing number of different-aged plantation forests in eastern North America, which are underrepresented in carbon sequestration studies. Research conducted at TPFS will help to add to our understanding of these ecosystems and, thus, help to improve regional models of carbon cycling.

4C3.1 **INVITED / INVITÉ**

Connecting SOLAS to Climate Change: Extrapolating to Larger Spatial and Longer Time Scales

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Observations conducted in the Surface Ocean Lower Atmosphere Study (SOLAS) for the most part are taken on spatial scales of a few 10s of km or less and over time scales of a few weeks at most. For example, in the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), a patch of the subarctic NE Pacific Ocean was fertilized with iron. Initially the patch was less that 10 km on a side and its evolution was then monitored from three ships for less than 1 month. Yet a goal of these studies is to improve our understanding of atmosphere-ocean exchanges and how this coupled system affects and is affected by climate and environmental change. The major tool for making projections of climate change is the ensemble of global climate models constrained by global data sets, usually run for several centuries. In this talk we consider the challenge of extrapolating from local to global scales, by considering two specific examples. First, we examine the uncertainties associated with the widely used Takahashi fields of global CO_2 exchange: spatial coverage, model extrapolation of observations, assumed height of wind fields, and parameterization of the dependence of CO_2 exchange piston velocity on wind speed. Second, we extend our model simulations of the surface ocean response to the SERIES iron fertilization for 6 months beyond the observations to illustrate non linear effects of small changes in parameterizations. To increase the impact of scientific findings from SOLAS on our understanding of global climate change, then we must test this new knowledge in global models as rapidly as feasible: feedback from these model studies can then influence the planning of future observational studies in SOLAS and related projects.

3DPA4.5

Évaluation de la variabilité et des extrêmes de précipitation et de température telles que simulées par le modèle régional canadien du climat

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On évalue les statistiques des extrêmes de températures et de précipitation tel que simulé par le modèle régional canadien du climat (MRCC, versions 3.6 et 3.7) en comparant avec les observations sur le Nord-Est des États-Unis, ainsi que le Sud-Est du Canada, là où le réseau d'observation est l'un des plus denses en Amérique du Nord. Plusieurs simulations couvrant la période 1961-1990 et utilisant une résolution de 45 km sont analysées et comparées aux données quotidiennes observées qui sont interpolées sur la grille du MRCC (2 à 10 stations par point de grille). Les simulations sont pilotées aux frontières par les réanalyses NCEP, ECMWF-ERA40C ainsi que par le modèle global canadien CGCM2. Les variables diagnostiques étudiées regroupent différents indices qui caractérise l'intensité, la fréquence et la durée des extrêmes.

Les résultats préliminaires indiquent qu'en été, le MRCC simule relativement bien le régime de température, notamment les vagues de chaleur et les extrêmes chauds, et que durant les autres saisons certains biais dans les extrêmes froids et chauds semblent plus substantiels. Le régime de précipitation analysé par des indices tel que la fréquence saisonnière des séquences humides, la durée maximum des séquences sèches et l'intensité des précipitations par jour de pluie sera étudié. Une fois la validation du modèle effectuée, nous comparerons cette période de référence (1961-1990) avec les résultats simulés pour le futur (2039-2070).

4C3.6

Adaptive Model for the Simulation of Ecological-Biogeochemical Dynamics in the Surface Ocean

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Cycling and air-sea exchange of major climatically active gases are intricately linked to the functioning of marine plankton ecosystems. Dynamic models of ecological processes are excellent tools to unravel these linkages and to work towards prediction. However, these models are also local in application and difficult to generalize over the large spatial scales of concern to SOLAS. Our first attempt during the Canadian SOLAS program at a basin scale physical-ecological model for the North Atlantic required local adjustments of the model parameters to reproduce the observed patterns in surface plankton and nutrients. Consequently, we have developed an adaptive model of marine plankton dynamics. An adaptive model uses variables which are properties of material variables, such as optimal temperature of phytoplankton and food preferences of zooplankton, to describe the internal structure of broad functional groups. Such properties offer the ability to increase the realism of relatively simple models by localising functions which are usually applied uniformly throughout the whole model domain, e.g., temperature-growth or predator-prey relationships. We show how the introduction of properties can improve both local simulations and model portability among three diverse sites in the North Atlantic. The adaptive formulation and its portability should make the model suitable for analysing data from SOLAS expeditions.

1B4.6

Evaluation of the Dehydration-Greenhouse Feedback on the Wintertime Tropospheric Temperature over the Arctic

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This research addresses an indirect radiative effect of aerosol on arctic wintertime cloud and climate, the dehydration-greenhouse feedback, which was originally formulated by Blanchet and Girard (Nature, 1994). The process may be summarized as follows. Anthropogenic and biogenic activities produce sulphuric acid, a northward extension of the mid-latitude acid precipitation problem, that coats most of existing aerosols. Previous field studies have shown that the increased concentration of sulphuric acid decreases the saturation vapor pressure above aerosol and lowers the freezing point. At cold temperatures, this process inhibits ice crystals production and favours the formation of fewer larger ice crystals instead of many smaller ones. In practice, it enhances formation of low-level precipitating ice crystals to the expense of more persistent ice fog or stratus. The dehydration of the lower atmosphere decreases the greenhouse effect and produces a surface cooling. The dehydration-greenhouse feedback is investigated using a 3D regional climate model. Results from simulations performed for February 1990 and for February and March 1995 will be presented.

2B1.3

Data assimilation versus tropopause inversion

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Recent vertically high--resolved climatologies of the extratropical tropopause region uncovered an inversion layer just above the tropopause, i.e. temperature strongly increases just above a sharp local cold point tropopause. Here, the question is addressed, to what extent such an inversion layer exists in current meteorological analyses and general circulation models (GCMs). Analyses merely exhibit a weak hint of the inversion layer, whereas the Canadian Middle Atmosphere Model (CMAM) exhibits an inversion layer of realistic strength and seasonal contrast, even though at a distinctly higher location compared to observations. The discrepancy between the analyses and the GCM is hypothesized to be mainly due to data assimilation acting as a smoother to the strong curvature of the thermal structure close to the tropopause. In fact, a version of CMAM that uses data assimilation (CMAM-DA) exhibits a much weaker inversion layer that resembles the one in the analyses. CMAM and CMAM-DA especially differ in the Southern Hemisphere where only coarsely resolved satellite data is available within the assimilation procedure.

2B2.7

Coincident Temperature Measurements from the Purple Crow Lidar and the ACE Satellite

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The Canadian Scisat ACE was successfully launched on 12 August 2003. The satellite's FTS is obtaining excellent occultation spectra that are being analyzed for trace gas species concentration as well as pressure and temperature. The University of Western Ontario's Purple Crow LIDAR (PCL) is participating in the validation of these pressure and temperature measurements. We will present some initial climatological comparisons between version 1.0 of the ACE-FTS retrievals and the PCL. The comparisons suggest the ACE temperature retrievals are reasonable. Four individual instances of ACE overpasses coincident with PCL temperature measurements will be shown in detail. These overpasses show the best and worse of the agreement between the two instruments at high temporal-spatial resolution. Three of the four nights show temperature differences typically less than 5 K with a small overall bias, while the fourth night shows a basis of several degrees compared to the lidar measurements.

1B4.5

An Evaluation of Eight ARCMIP Regional Climate Models: Cloud and Radiation

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Cloud and radiation variables are extracted at the location of the Surface Heat Budget of the Arctic Ocean (SHEBA) experiment site from eight different regional climate models (RCMs) simulation during September 1997-September 1998, which simulations are run for the same domain covering the western Arctic, the same horizontal resolution, the same lateral boundary and sea ice conditions. The variables of cloud cover, downward solar radiation on the surface, downward longwave radiation on the surface, surface albedo, precipitable water path, water vapor path and liquid water path, for each model are evaluated against the SHEBA observation data and the co-variability between the cloud and radiation is analyzed. Compared to the observations, all models agree well with the observed downward solar radiation and downward

longwave radiation at the surface even though some apparent variability between the different models due to the difference of the vertical resolution and physical parameterizations among models. However, for the variables controlling the radiative transfer, cloud cover and cloud condensate, the RCMs don't reproduce well with the observations, and the disagreement between models is very large but none of the models shows up as being superior to the others.

4DPA6.27
Calibration of the Purple Crow Raman Lidar Water Vapour and Temperature Measurements
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The UWO Purple Crow Lidar (PCL) is a large power-aperture product lidar which has been operational since 1992 at the Delaware Observatory near London, Ontario, Canada. In 1999 the PCL was modified to allow the measurement of the vibrational Raman-shifted backscatter from both nitrogen and water vapour molecules. PCL measurements of the vibrational Raman-shifted backscatter from nitrogen molecules allow the determination of temperature profiles from about 10 km up to about 40 km altitude. The ratio of the measurements of the vibrational Raman-shifted backscatter from water vapour and nitrogen molecules allows height profiles of water vapour mixing ratio to be determined in the altitude range from 500 m to the lower stratosphere. External calibration of the temperature and water vapour measurements is necessary to compensate for instrumental effects, uncertainties in our knowledge of the relevant molecular cross sections, and atmospheric transmission. A comparison of the PCL derived water vapour concentration and temperature profiles with routine radiosonde measurements from Detroit and Buffalo on 37 and 141 nights respectively, was undertaken to provide this calibration. The calibration is then applied to the measurements and monthly mean temperature and water vapour profiles are determined, which will be compared to previous climatologies.

1B2.5
Drylines Observed in Alberta During A-GAME
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The 'dryline' is a boundary layer convergence zone between relatively dry air to the west and relatively moist air to the east that develops in the lee of the Rocky Mountains. It has been studied extensively in the High Plains of the U.S. and is often associated with the development of thunderstorms. The Alberta GPS Atmospheric Moisture Evaluation (A-GAME), operating during the summers of 2003/2004, provided a unique opportunity to examine the dryline in south-central Alberta. The dryline was detected primarily using surface observations of water vapour mixing ratio collected using a mobile transect and/or a stationary line of weather stations in the foothills in collaboration with A-GAME. A total of seven dryline events were detected during July and August of 2003 and 2004. The development of nearby convective storms was observed in five of these events, and in at least one case the convection that developed along the foothills became severe (producing 2-cm diameter hail). The magnitude of the water vapour mixing ratio gradient across the dryline measured during this investigation in Alberta was similar to that observed over the High Plains. The new information regarding the dryline in Alberta will be used to update the multi-scale conceptual model of thunderstorm development in this area of Canada. Improved understanding (by both researchers and forecasters) of any important feature influencing convective development along the foothills is vital; severe weather in Alberta, including severe hailstorms and tornadoes, costs millions of dollars in damage annually.

1C3.7

Progress in the Development of Unstructured Grid Algorithms for Climate Simulation

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A principal mechanism for climate instability precipitated by global warming is associated with the dynamics of the Arctic ice cap, which is much more prone to melting than its Antarctic counterpart. One of the possible reasons for the fragility of the northern sea ice is the complex geometry of the land-sea boundary in the Arctic archipelago. Numerical investigations of this possibility are complicated by the fact that existing global climate models are less than optimal in their representations of coastal and small-scale geometries. To facilitate more reliable multi-scale modeling of relevant fluid dynamical and rheological processes, we are developing numerical methods based on unstructured triangular grids, which have been shown in coastal and regional ocean modeling studies to offer a high degree of geometric flexibility. As a first step, these methods have been applied to a prototype global ocean model. Our numerical techniques overcome many of the challenges posed by global unstructured grid ocean modeling in a natural way, and appear to represent the first successful efforts in this potentially fertile area of research. Algorithm robustness is ensured through the enforcement of energy conservation over finite volumes. This inhibits most numerical modes of instability, a property that is being exploited in modern large-eddy simulations of turbulence. A selection of numerical results relating to stratified rotating turbulence and global ocean dynamics will be discussed. The methods have been validated for 3-D stratified flows in spherical geometry in the rigid-lid, hydrostatic Boussinesq limit. Ongoing work is focused on the generalization of the energy-conserving discretization to free-surface dynamics (which are important for tidal and sea-level change simulations) and transformed vertical coordinates.

1DPA1.5
Fog Climatology based on GOES channel differencing method

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This objective of this work is to test a satellite based analysis for long term studies of fog climatology within the framework of the Fog Remote Sensing and Modelling (FRAM) project. The purpose of the FRAM project is to study the characteristics of fog in Canada and to develop methods to improve the analysis and forecasting of fog. The project has a number of components including field studies, numerical modelling and climatological studies. In this paper we will outline the goals and methods being used in the project. In particular we will outline some preliminary results in a satellite-based fog "climatology". Using Channel 4 minus Channel 2 on the GOES satellite to determine areas with a high probability of stratus or fog is well known. We show maps of Channel 4 minus Channel 2 for different regions of Canada for the months of August and September for the past 3 years and interpret them in terms of geographical and meteorological factors. One possible application of this study is to determine areas which may be prone to formation of radiation fog which has been implicated in serious traffic accidents. This work will also be a reference for long-term studies of fog characteristics over various geographic regions.

2DPA5.5
Tropospheric circulation controls on mid-latitude terrestrial carbon dioxide exchange

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Eddy covariance measurements of CO_2 exchange made at eight long-term monitoring sites throughout the North American mid-latitudes were related to modes of tropospheric circulation in

order to understand ecosystem responses to climate fluctuations. Cleaned eddy covariance data were gap-filled uniformly using relationships with ancillary meteorological variables and then integrated Net Ecosystem Productivity (NEP) was related to Rotated Empirical Orthogonal Functions (REOFs) of 500 hPa height over the western quadrant of the Northern Hemsiphere. Significant correlations were found between monthly REOFs and NEP at all eight ecosystems, however, only a few of the leading REOFs exhibited consistency (regional coherence) in the control over fluxes. The relationships were most pronounced during March-May, when the second and third REOFs, centred over the extratropical Pacific Ocean and Hudson Bay, respectively, influenced temperature in the central boreal region. Fluctuations in the Icelandic Low (REOF 6) resulted in an east-west dichotomy in North American temperature and precipitation. During May, this mode amplified NEP at eastern sites and inhibited NEP at a west coast site. Other correlations existed between fluxes and the lower-order modes of 500 hPa height at monthly, five-daily, and daily time scales, but exhibited less coherence between sites.
The relatively high degree of certainty in the long-term flux records provided a valuable means for understanding the proportion of flux variability driven by external climatic processes. This research compliments inverse and process model-based methods of understanding the influence of synoptic-scale climate variability on the terrestrial carbon cycle, which will be crucial in forecasting the carbon cycle feedback to future greenhouse warming.

1C4.7
A High Resolution View of the Reverse Greenland Tip Jet
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For several years now, it has been known that the interaction of synoptic scale cyclones with the orography of Greenland can spawn westerly high wind speed events off the east coast of the tip of the island (Doyle and Shapiro, 1997). These events are known as tip jets, and have a relatively narrow north south extent of 100-200 km, with a much longer east west extent of ~1000 km. Subsequent studies of the climatology of these events showed that, in fact, tip jets could have either a westerly (normal) or easterly (reverse) sense. The sense that a tip jet might have is very closely related to the manner in which a synoptic scale cyclone interacts with the island. Cyclones that track off the east coast of the island tend to form normal tip jets, while those that actually impinge upon the island can form the easterly reverse tip jet.

In this talk, we will present the results of a high resolution simulation done with MM5 of a reverse tip jet that occurred in late December 2000. The simulation will be compared with available Quickscat and MODIS data. These simulations have particular application to the coming International Polar Year, as there will be opportunities to obtain observations of the tip jet in order to better understand it. It is expected that results obtained from this work will be used to better target the observational studies.

4B1.4
The effect of organic compounds on the growth rate of cloud droplets during a marine and a forest field study
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Organic aerosols represent an important fraction of the fine particle aerosol, yet our knowledge of the roles of organics in the activation of particles into cloud droplets is poor. The goal of this work was to determine how organic aerosols behave as cloud condensation nuclei (CCN).
A cloud condensation nucleus counter (CCNc) was used to evaluate the initial growth rates of cloud droplets in field experiments. A model of the condensational growth of water droplets, on

particles dissolving according to their solubility in water, was used to simulate the initial droplet growth in the CCNc.

Simulations of the growth rates of marine particles, which were predominantly composed of acidic sulphate, compared well with the observations, giving confidence in the field observation simulations. The results from one marine case with a significant organic mass fraction (30%) suggested that the main influence of the organic on the water uptake rate was from its influence on the size distribution of the sulphate rather than an effect on the water condensation rate. Simulations of the observations from a case of relatively high organic mass fractions (80%) indicated an impact of the organic on the rate of water uptake, but this impact was smaller than that of pure sulphate particles.

Overall, the results indicate that sulphate is the dominant chemical species controlling the water uptake rate of particles growing into cloud droplets. For cases which have relatively high fractions of soluble organic material, the organic may also contribute to the water uptake.

4DPA6.32

Mechanism Reduction for the Formation of Secondary Organic Aerosol for Integration into a 3-Dimensional Regional Air Quality Model

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Secondary Organic Aerosol (SOA) plays an important role in atmospheric chemistry, regional and global climate, and human health. It is important to develop a reduced yet accurate chemical mechanism for the formation of both ozone and SOA in a regional air quality model to alleviate CPU time and memory burden.

In this work, an almost-explicit gas phase Master Chemical Mechanism (version 3) is used as a benchmark for the study of the formation of SOA. Five mechanism reduction techniques have been applied in sequence to a subset of MCM describing alpha-pinene oxidation (ca. 930 reactions and 300 species in the original mechanism) coupled with a gas/particle partitioning model to create reduced mechanism preserving the properties of the original mechanism, while using less species.

First, a method based on resolving species interaction has been shown to remove efficiently a large number of redundant species and reactions under a wide range of conditions. Next, the application of principal component analysis (PCA) of the rate sensitivity matrix and the use of quasi-steady-state approximation (QSSA) have been used to eliminate some reactions and remove some QSS species, respectively. The fourth stage is to use an iterative screening method to remove the redundant species and reactions simultaneously. A new lumping approach is developed and implemented to reduce the number of species in the final stage.

This methodology results in a reduction ratio of 3 for the number of species and reactions compared with the full mechanism. The simplified mechanism is demonstrated to reproduce well of the important gas and aerosol phase species in the SOA formation.

3C1.5
Temperature Climatology Measured by Rayleigh and Raman Lidar Over Southwestern Ontario
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The Purple Crow Lidar (PCL) is a large power-aperture product monostatic laser radar which has been in operation at the Delaware Observatory (42.9 N, 81.4 W, 225 m elevation above mean sea level) near the campus of The University of Western Ontario since 1992. The PCL is capable of making simultaneous measurements of Rayleigh, Raman and resonance fluorescence scattering, which allows temperature, constituent density and gravity wave parameters to be simultaneously determined from the troposphere to the lower thermosphere.

Temperature measurements from the PCL Rayleigh lidar taken during the 11 year period from 1994 to 2004 are used to construct a temperature climatology of the middle atmosphere from 12 to 96 km. The derived temperature climatology is compared to the CIRA-86 climatological model and to other lidar climatologies. The PCL climatology agrees well with the climatologies of other Rayleigh lidars, however it is significantly different from sodium lidar climatologies, as well as from the CIRA-86 model in the mesosphere. The large power-aperture product of the PCL allows for the first time a direct comparison with the sodium lidar results with the well-established Rayleigh-scatter temperatures. Some possible reasons for these discrepancies will be discussed. The amplitude and phase of the annual and semi-annual oscillations have been calculated from the measurements and compares favorably with those estimated from other Rayleigh-lidar data sets.

3DPA1.2
Mesoscale Simulations of the Greenland Tip Jet
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Greenland lies in close proximity to the northern branch of the North Atlantic storm track, and as such can be a point of strong orographic interaction with atmospheric flow. The tip of Greenland is also frequently the source of high wind speed events called tip jets. Because of their mesoscale nature, tip jets are not well resolved, or even at all resolved by most GCMs. However, it has been found through ensemble forecasting and analysis of error growth that the region around Greenland is often very sensitive to initialization errors in weather forecasts. In order to possibly understand some of the dynamical causes of these initialisation errors, it is important to simulate these events with a fairly high-resolution mesoscale model in order to better understand the processes associated with sub-synoptic processes near Greenland such as the tip jet. In addition, the surface heat fluxes associated with these events may not be well estimated by model boundary layer parameterizations, and this can in turn effect the initialisation and potentially the upscale cascade of energy resulting from the air sea interaction and inertia-gravity wave breaking over the island (Shapiro and Thorpe, 2004). In this presentation, we will show MM5 output of a tip jet event and discuss the synoptic development leading to it, an analysis of its genesis and lifetime, and an overview of the subsequent downstream effects.

1A1.1 **INVITED / INVITÉ**

Complementary contributions of correlative and satellite measurements to validation and science

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NASA's Aura, the third of the large Earth Observing System platforms, was launched July 15, 2004. Aura carries four instruments; all measure atmospheric composition. These instruments were designed to make measurements in the troposphere and lower stratosphere where natural variability is significant. Validation of the Aura instruments relies on correlative measurements from ground-based, balloon borne and aircraft instruments, as well as measurements from other satellites. Aura instruments require validation under a variety of environmental conditions - in clean and polluted atmospheric conditions, under different surface conditions and within both the troposphere and stratosphere. Because of atmospheric variability, coincidence requirements are stringent. Aura investigators have participated in field campaigns designed to provide correlative measurements, and also in campaigns that provide validation data while attacking their own science questions. The complementary nature of satellite and correlative observations can be brought to bear on science questions. For example, during winter 2005 an inward-wave breaking event produced a filament of middle latitude air within the polar vortex. This filament was intercepted by the DC-8 during the Polar Aura Validation Experiment and also observed by the Microwave Limb Sounder. Direct comparison of ozone measured by the aircraft lidars with the MLS shows that MLS resolves features a few degrees latitude wide along the satellite track. Polar stratospheric cloud observations made during the flight can be explained by analysis of MLS observations of HNO_3 and H_2O. Results from such analyses that use Aura measurements along with correlative observations will be presented.

2DPA6.10

Variations in Gravity Wave Energy Density in the Stratosphere Measured by the Purple Crow Lidar: Seasonal Averages

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The Purple Crow Lidar (PCL) is a large power-aperture product monostatic laser radar which has been in operation at the Delaware Observatory near the campus of The University of Western Ontario since 1992. The PCL is capable of making simultaneous measurements of Rayleigh, Raman and resonance fluorescence scattering, which allows temperature, constituent density and gravity wave parameters to be simultaneously determined from the troposphere to the lower thermosphere.

Average nightly gravity wave energy density has been calculated from the Rayleigh-scatter system measurements. The gravity wave energy density is typically largest in the upper stratosphere relative to the mesosphere. There are no clear seasonal trends, but the energy density appears to decrease rapidly in the fall relative to the late summer. The nightly variability of the gravity wave energy density is often extremely large, with 50 to 100% RMS fluctuations about the mean energy at all heights, masking any seasonal effects.

2DPA6.6

The effect of the rigid lid position on hemispheric simulations using the Canadian Regional Climate Model

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Regional Climate Models require time-dependent lateral boundary conditions, usually from reanalyses or simulations from General Circulation Models (GCM). The data has horizontal resolutions of ~400-500km which is one order of magnitude coarser than the 45km resolution of the Canadian Regional Climate Model (CRCM). To reduce this jump in resolution, a hemispheric configuration of the CRCM has been tested at an intermediate (180 km) horizontal resolution, in the hope to self-nest the RCM at 45km. The results of this study showed that large negative biases in the temperature field mainly seen in the lower stratosphere were generated after a short simulation period. The changes in the vertical temperature structure modify the large-scale circulation. Some assumptions are made regarding the causes of these biases; it is hypothesized that the position of the rigid lid at an altitude around 30km inhibits some dynamical processes existing in the stratosphere.

In this project, emphasis is put on two phenomena supposedly important in ruling simulated temperature and dynamical fields in the CRCM's upper domain: the Stratospheric Meridional Circulation (SMC) and the inclusion of zones where the gravity wave drag parameterization (GWD) is active. We analyze the impact of a modification in the position of the upper boundary on the simulation made by the CRCM. A pair of experiences with the upper boundary at 29km and 45km will be compared to detect if the CRCM simulates the SMC and if the inclusion of active GWD zones tend to correct the biases.

(243 mots)

4DPA6.8

Laboratory spectroscopic measurements of the infrared absorption cross-sections of CFC-113

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CFC-113 (CCl_2FCClF_2) is the third most abundant CFC in the atmosphere. Although its emission is now controlled by international regulations, the long lifetime of this compound makes its monitoring essential. Atmospheric measurements of CFC-113 on a global scale have recently become available from the Atmospheric Chemistry Experiment (ACE) satellite mission. However, the uncertainties in the spectroscopic parameters currently available for this molecule compromise strongly the accuracy of the ACE retrievals.

The purpose of this work is to provide absorption cross sections of CFC-113 for different pressures at several temperatures between 200 and 300 K to allow more accurate measurements of its concentration profiles in the atmosphere.
The infrared cross sections of CFC-113 is measured by Fourier transform spectroscopy using a Bomem DA8 spectrometer equipped with a KBr beam-splitter and a MCT detector. The CFC-113 is contained in a 25-cm-long temperature-controlled steel cell with ZnSe windows.
A theoretical computation of the harmonic vibrational frequencies and intensities of CFC-113 has also been performed using the time-dependant density functional theory and compared to experimental data.

4B2.5

Dynamics of the Slope Sea near Cape Hatteras

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The oceanographic region between the Gulf Stream and the continental margin north of Cape Hatteras was designated as the “Slope Sea” by Csanady and Hamilton. Our study focuses on the southern extreme of the Slope Sea, over a region of the slope extending roughly 100 km to the north of Cape Hatteras. Using a collection of data, including vertical CTD profiles, measurements from an undulating towed vehicle (ScanFish) and underway ADCP data, we investigate the dynamics of this region with emphasis on small-scale structures and water mass mixing. During our two study periods (Aug. 2004 and Jan.-Feb. 2005), we find a complex mixture of different water masses occupying the southern Slope Sea. These include slope and shelf water of Middle Atlantic Bight and water discharged from the Gulf Stream. Much of the latter water mass appears to have upwelled from deeper, nutrient rich, layers of the Gulf Stream. A rich and rapidly evolving eddy field facilitates mixing of these water masses. The eddies observed have length scales of 20-40 km and extend vertically over roughly 200 m. All are highly baroclinic and many are weakly non-linear (Ro order 0.2). The properties of the core water of these eddies vary significantly. Some eddies are comprised principally of discharged Gulf Stream water, while others are primarily made up of Middle Atlantic Bight Shelf water. Many eddies are highly energetic with angular momentum and kinetic energy contents comparable with large eddies observed in other continental slope regions. These eddies, and other processes, often result in interleaving of different water masses. At the vertical interfaces of these water mass layers, conditions are often amenable for strong vertical mixing through shear-induced and double diffusive instabilities. The mixing and stirring of the water masses observed in the southern Slope Sea have important biological implications, which are explored using bio-chemical data acquired with the physical measurements.

1DPA1.7

Warm-season blocking over North America

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Considerable research has been performed on persistent-anomaly structures for the Northern Hemisphere winter. However, atmospheric blocking structures during the warm season also have a considerable impact on weather and climate, as manifested through heat waves, floods, and droughts. In particular, atmospheric blocked flow has a profound impact on anomalously-dry regimes over the central North American continent.

In order to provide a better understanding of the life cycle of the atmospheric blocking events and their relation to fast-climate phenomena, we analyze persistent height-anomaly structures derived from the National Centers for Environmental Prediction (NCEP) global reanalyses. We derive an objective criterion for the characterization of blocked flow by relating it to persistent positive height anomalies. Individual warm-season events over the North American continent are then identified and examined in case studies. This reveals a type of blocking regime, differing in structure from the “Rex” and “Omega" type blocks described in the literature, as being important in the region during summer. Moreover, changes in the statistical distribution of the event frequencies are analyzed in order to detect climatic trends. We find a pronounced westward displacement of the North American event frequency maximum to be associated with the 1999-2004 drought in the Canadian prairies.

3B3.5
The ENSO Response to High Latitude Freshwater Forcing: Atmosphere and Ocean Teleconnections
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The importance of ocean thermohaline circulation variability upon climate system instability has led to a number of modelling studies of the impact of freshwater forcing (FWF) applied to high latitude ocean basins. Recently, a new focal point involves the proposition of an Arctic FWF mechanism for the Younger-Dryas cold reversal. We describe a series of experiments, constructed using the NCAR CSM v1.4, in which a range of different FWF anomalies have been applied to the North Atlantic and Western Arctic Basins. The FWF applied in each of the two basins varies from 0.1Sv to 1.0Sv, for varying durations of time, usually 100 years in length. These experiments form a collection of studies that attempt to assess the mechanisms for climate instability during the last deglaciation. In understanding rapid climate transitions from one state to another, a reoccurring theme is that of the global response to northern hemisphere cooling under reduced Atlantic meridional overturning circulation. In particular, the response in tropical climate variability to a FWF event manifests itself most prominently in changes that occur in the behaviour of the ENSO phenomenon. We will present evidence for mechanisms that invoke both atmospheric and oceanic pathways through which the northern hemisphere high latitude forcing is transferred into changes in tropical variability. Some notable climate dynamical mechanisms involve a repositioning of the atmospheric Hadley Cell and the Intertropical Convergence Zone. Changes in the characteristics of the oceanic Kelvin and Rossby wave pathways in response to northern hemisphere cooling will also be discussed.

4DPA6.19
A new wet scavenging scheme for use in atmospheric dispersion models
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Aerosols or gases released into the atmosphere may be deposited to the ground through wet scavenging and dry deposition. In this study, a new wet scavenging scheme was developed for the purpose of simulating wet removal processes in atmospheric dispersion models. The new scheme includes the below-cloud scavenging of aerosols/gases by rain and snow, and the in-cloud scavenging of aerosols/gases. Some of the more important factors affecting the wet scavenging efficiency, such as aerosol number size distribution, gas molecular diffusion coefficient, rain droplets/snow aggregates size distribution, and spectral collision efficiency between aerosol particles and rain droplets/snow aggregates are taken into account in the scheme. The new scheme parameterizes the wet scavenging coefficient on-line based on the explicit calculations. The scheme has been incorporated into a short-range dispersion model MLCD. The simulated wet deposition of tritiated water vapor (HTO) by MLCD was compared with some observations done in 2004 at Chalk River Laboratories, Atomic Energy of Canada Limited (AECL).

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2B3.3

Comparison of carbon fluxes over three boreal black spruce forests in Canada

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In 2004, year-round eddy covariance flux measurements were made for the first time over an old black spruce (OBS) forest in eastern Canada (EOBS, Quebec) concurrently with two other OBS sites in different climatic regions in central Canada (SOBS, Saskatchewan and NOBS, Manitoba). On an annual basis, SOBS and NOBS were weak C sinks (29.2 and 26.9 g C m^{-2} y^{-1}, respectively), while EOBS was C neutral (4.1 g C m^{-2} y^{-1}). Annual total GEP and R were 689.6 and 660.4 g C m^{-2} y^{-1}, respectively, at SOBS, 583.7 and 579.5 at EOBS, and 564.6 and 537.7 at NOBS. The greater annual totals of GEP and R were associated with longer growing seasons. Seasonal patterns of C fluxes were similar among sites. All sites were C sinks from May to September, maximum monthly gains occurred in June (NEP = 34.4 – 56.7 g C m^{-2} $month^{-1}$), and a mid-summer depression was observed in July for all sites. Warmer soil under a thicker snowpack at EOBS was associated with greater winter C losses. SOBS had the highest maximum photosynthesis while NOBS showed the highest light use efficiency. At the daily and monthly scales, temperature drove both GEP and R. All three sites showed a similar response of relative daily GEP (daily GEP / maximum daily GEP) to temperature. The response of daily R to soil temperature was site specific and greater temperature sensitivity and basal respiration were associated with lower mean annual soil temperatures. At the monthly scale, R and GEP response to temperature did not differ among sites.

2B4.4

Improvement of surface air temperature seasonal predictions by statistical correction using the leading ocean-forced spatial patterns

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A statistical approach is developed to correct the seasonal surface air temperature (SAT) forecasts of two global dynamical models (GCM3 and GEM). The approach is based on a linear regression between the observed and predicted seasonal mean SAT anomalies. The SAT

anomalies that are considered are those that are related to the Tropical Pacific sea surface temperature SST anomalies, as revealed by a Singular Value Decomposition (SVD) analysis. The correction method is applied to mean winter forecasts made available by the Historical Forecasting Project for 30 winters (1969 to 1998).

We have verified whether the statistical method improves the predictions of the SAT patterns associated with the Southern Oscillation Index (SOI), i.e., the ENSO, and the North Atlantic Oscillation (NAO) index. The results show that the method substantially improves the predicted SAT patterns associated with the SOI in the GEM model. For the GCM3 model there is no improvement, likely due to the fact that the original, uncorrected, forecasts are already good. As for the SAT pattern associated with the NAO index, the improvement in the forecasts by the statistical method is significant for both models.

Work is underway to determine the extent to which the statistical improvements described above translate into actual forecast skill scores, i.e., when all the variability in the observations is considered, as opposed to only the variability linked to the SOI and NAO.

2B2.8
Canadian Arctic ACE validation campaign: results from 2004 to 2006
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Three Arctic measurement campaigns have been conducted in Eureka, Nunavut to validate results from the Atmospheric Chemistry Experiment (ACE) satellite mission. Two instruments, on-board the ACE satellite, provide measurements of atmospheric trace gases: a high-resolution infrared Fourier Transform Spectrometer (ACE-FTS) and a dual UV-visible-NIR spectrophotometer called ACE-MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation).The validation campaigns were conducted at Environment Canada's Arctic Stratospheric Ozone (AStrO) Observatory (now PEARL - the Polar Environment Atmospheric Research Laboratory) in Eureka, Nunavut (80°N, 86°W) between February and April in 2004, 2005 and 2006. Seven ground-based instruments took part: a ground-based version of the ACE-FTS (PARIS-IR - Portable Atmospheric Research Interferometric Spectrometer for the Infrared), a clone of the ACE-MAESTRO, a SunPhotoSpectrometer (SPS), a zenith-viewing UV-visible grating spectrometer, a Bomem DA8 Fourier transform spectrometer, a Differential Absorption Lidar (DIAL) and a Brewer spectrophotometer with, in 2005 and 2006, a SAOZ (Systeme d'Analyse par Observation Zenithale) instrument and an additional Brewer spectrophotometer. In addition to the ground-based instruments, balloon-borne ozonesondes were flown. The validation period coincides with the most chemically active time of year in the Arctic and with a significant number of satellite overpasses.The focus for this paper is on ozone, nitrogen dioxide and temperature measurements made by the ground-based, balloon-borne and satellite-borne instruments during the three ACE Arctic Validation campaigns. Comparisons of both retrieved columns and profiles will be presented and comparisons from the three campaigns will be shown to highlight the differences between the years.

1DPA3.3
Measurements of blowing snow particle size, number, and velocity
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A novel system has been developed to measure blowing snow particles. A CMOS digital camera has been automated to record the shadows of blowing snow particles as they pass before a collimated LED. Results of this system are compared to concurrent measurements of blowing snow particle number density (measured using particle counters based on the design of Brown and Pomeroy), mass flux of blowing snow (measured using the FlowCapt instrument of IAV Engineering), and standard meteorological data and snow conditions. Particle size distribution measurements are compared to other experiments which used a variety of other techniques. It is found that the results can be described by the Gamma Distribution suggested by previous research. However, the mean particle size measured using the camera system is somewhat larger than previous measurements.

1DPA4.16
Energetics of QG gyres: effect of wind stress dependence on ocean surface velocity
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The classic midlatitude double gyre problem typically assumes the wind stress (air-sea momentum transfer) to be specified --- i.e., to be a function of atmospheric variables alone. Recent satellite evidence(e.g., Chelton et al., 2004), however, clearly shows the wind stress to also depend on the surface ocean currents. The QG double gyre problem is thus revisited to take this effect into account. Specifically, we compare simulations with and without allowing for a surface ocean velocity dependence in the stress. Consistent with scaling arguments, we find this to reduce the wind power source by roughly 1/3. Essentially, part of the energy input to the ocean --- which occurs primarily at large horizontal scales is transferred back to the atmosphere from the ocean mesoscale. A "twin experiment" is also carried out to point out possible pitfalls with directly applying scatterometer-derived wind stress products (in which the ocean-current-dependence is clearly visible) to ocean models. The potential problem which arises is that the modelled currents won't typically coincide perfectly with observed currents. As such, systematic correlations which should exist between the stress associated with currents and the currents themselves is compromised. Additionally, the effect of vertical resolution on the existence of multiple statistical equilibria seen in our simulations (which have a relatively high effective Reynolds number) is discussed.

2B4.1 **INVITED / INVITÉ**
Seasonal forecasting and the HFP
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Seasonal forecasts have been produced by means ranging from the Farmer's Almanac secret methods, to subjective judgment, to mixtures of subjective judgment and objective guidance, and to varieties of objective methods both statistically and physically based. The difficulties in producing skillful seasonal forecasts and their modest skill are notable but this has seldom prevented their production and dissemination. When the CMC sought to produce seasonal forecasts a combination of circumstances led to a consortium of MSC and University investigators, together with CMC applications, proposing, producing, analyzing, verifying and implementing an objective seasonal forecast system. Support from MSC and the CLIVAR Network permitted this collaborative effort which is still underway. The heart of the seasonal forecasting effort was the Historical Forecasting Project (the HFP), a sequence of retrospective forecasts that provided the information needed to verify the skill of the forecasts, to analyse forecast behaviour, and to allow bias removal and other forms of post-processing leading to enhanced skill. The evolution of the HFP into HFP2 and its relation to and influence on other seasonal forecasting efforts such as SMIP/HFP, the APCN/APCC MME, and the COPES TSFP

will be mentioned and some results concerning seasonal/interannual to decadal predictability will be discussed. Finally, future activities and possibilities will be touched on.

1DPA4.6
Energetics of midlatitude gyres: can balanced-to-unbalanced energy transfers play a significant role?
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Large scale atmospheric winds provide the principal mechanical energy source that drives midlatitude ocean gyres. Typically, energy is input at large scales by a specified wind stress and is transferred to the ocean mesoscale (e.g., boundary current and eddies) by instabilities and processes occurring at the western boundary. Further down scale transfer to scales where molecular processes convert this energy to heat are generally thought to occur in association with a bottom boundary layer. Here, we consider the possibility that a breakdown of balance (and subsequent forward energy cascade) might also play a role. Specifically, we revisit the nonlinear barotropic Stommel double gyre problem, but allowing for the barotropic flow to interact with unbalanced near-inertial oscillations. The equations assume a constant density (i.e., stratification effects are ignored) and make a thin aspect ratio assumption. In the absence of vertical structure, the 2D Navier-Stokes system is recovered. Linear vertical modes correspond to inertial oscillations. In the absence of any external forcing of these unbalanced modes, one expects an approximate balance to develop. In other words, one expects any (weak) initial vertical structure to die out, leaving behind a barotropic flow. When unbalanced modes are directly forced, however, significant balanced-to-unbalanced energy transfers become possible, at least in regions where the Rossby number is O(1), e.g., such as in boundary currents and their seaward extensions. The extent to which these transfers influence the barotropic ``Stommel'' gyres is thus explored.

1C3.4
Gravity Waves in Nonlinear Sequential Data Assimilation
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Atmospheric and oceanic data assimilation is becoming increasingly four-dimensional, meaning that error information is spread in both time and space using a dynamical model, resulting in better use of both observations and simulations. However, the atmosphere and ocean both contain motions of various time scales, and these are not independent of each other. Specifically, gravity waves coexist with comparatively slow vortical motion, and may (for example, in the mesosophere) carry significant energy and thus account for a large part of the total variance. This makes it difficult, in data assimilation, to interpret information from observations, especially since these tend to be brought in on slower timescales than that of the gravity waves. This talk will discuss the mechanisms with which sequential 4D assimilation algorithms handle, and the problems associated with, states where gravity waves are not negligible compared to the coexisting slow motion. Numerical experiments using a simple model show that error covariance evolution based on tangent-linear model dynamics becomes more unstable under the presence of gravity waves. Ensemble-based covariance evolution is more stable, but well-known problems in ensemble prediction (due to sampling error and gaussianity assumptions) seem to become more pronounced as gravity wave energy increases.

3DPA4.2
Evaluation of statistical Downscaling tools: reconstruction of the variability and extremes of monsoon regime in Sahel

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A collaborative project, between western African countries through the AGRHYMET (AGRiculture, HYdrologie and MÉTéorologie) research center in Niamey (Niger), and Canadian partners, namely Environment Canada and the University of Québec at Montréal, is engaged in developing the adaptive capacity faced to climate changes. In the context of high poverty and strong economic dependence on local agriculture, all potential changes in precipitation regime including extreme events in that region will exacerbate the pressure on both human health and activities, and key ecosystems, as experienced with the recurrence of drought periods in the last decades. Global climate models (GCMs) with their coarse resolution have limited capacity to simulate wet and dry spells as well as the extreme events of precipitation in the monsoon areas where mesoscale convective processes dominate. In order to construct reliable climate change scenarios, the downscaling tools based on dynamical and statistical methods are needed to improve the confidence in precipitation changes. In that perspective, the main objective of this study is to evaluate two statistical downscaling tools on their capability to reconstruct the occurrence and intensity of precipitation events. Some development on new key atmospheric predictors from two reanalysis data series (NCEP and ECMWF) has allowed simulating the occurrence of wet and dry series relatively well compared to observed ones, over few stations in Burkina Faso. Downscaling results driven by two series of GCMs predictors, suggest some added values compared to GCMs raw outputs for both the occurrence and duration of precipitation events including dry sequences. However, some discrepancies still remain for the variability and extremes of precipitation.

4B4.7
Volcanoes and Climate Sensitivity
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Climate sensitivity is a basic measure of the global temperature response to a change in GHG concentration, aerosol loading or other radiative perturbation to the climate system. Since the sensitivities of current climate models differ by a factor of two, it is desirable to obtain climate sensitivity from observations of the actual climate system. One possibility is from observations of volcanic events. We ask if this can be done even in the "perfect model" worlds of the CCCma CGCM3 and the NCAR CCSM2. These models, which have considerably different climate sensitivities, are forced with a volcano-like radiative perturbation and the responses analyzed. We show that the models' climate sensitivities cannot be obtained from a knowledge of the temperature response alone, even if the radiative forcing of the volcano is known. If both the forcing and the heat storage in the system, either from observations of oceanic heat storage or the TOA radiative flux, are available then it is possible to obtain a reasonable approximation to the equilibrium climate sensitivity. The accuracy to which these quantities need to be known is daunting, however, so the volcanic approach to inferring climate sensitivity is moot.

1DPA2.22
Seasonal Variability in NOy from ACE-FTS and the Canadian Middle Atmosphere Model
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Stratospheric odd nitrogen (NOy = NO + NO2 + 2.N2O5 + HNO3 + HNO4 + ClONO2 + BrONO2) has an important role in determining the photochemical balance of stratospheric O3, both through

catalytic cycles and interactions with other chemical families. The Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS), launched in August 2003, provides simultaneous measurements of nearly all species in the NOy family. Vertical profiles of NO, NO2, N2O5, HNO3, ClONO2 and NOy retrieved from ACE-FTS solar occultation spectra will be presented. Latitudinal and
seasonal variability in the observations will be explored, along with correlations between NOy and O3, and NOy and the long-lived tracer N2O. These results will also be compared with output from the Canadian Middle Atmosphere Model (CMAM), a fully interactive chemistry-climate model run in climatological mode.

3DPA1.1
A Regional Ensemble Prediction System Based on Targeted Moist Singular Vectors and Stochastic Parameter Perturbations
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A regional ensemble prediction system (REPS) with the GEM-LAM model is being developed. We explore the possibility of representing the uncertainties in
initial conditions with targeted singular vectors (SVs) and the uncertainties
in model physics with key parameters perturbed by stochastic processes.
The total energy norm SVs with 24h optimization time at horizontal 140-km resolution are calculated. They are added to (and substracted from) a global
100-km resolution initial condition to form an ensemble of pilot runs used to provide an ensemble of limited-area integrations. Two initial (and boundary) perturbation strategies with these SVs are tested: (1) Moist targeted SVs, including two simplified moist physics processes, stratiform condensation and deep convection, as well as two dry physics, vertical diffusion and subgrid-scale orographic wave drag; (2) Dry targeted SVs for which only two simplified dry physics are used. Currently, the REPS is designed with 17 members (including an unperturbed control run) at 15 km horizontal resolution, and the domain of interest is located over eastern Canada. Eight rescaled SVs are used to perturb the
global 3D-Var analyses and produce 16 perturbed initial and boundary conditions. First order Markov chains are utilized to randomize some key parameters to represent the uncertainties in the physics. So far, two parameters closely related to precipitation processes, CAPE in the
Kain-Fritch scheme and a threshold humidity in the Sundqvist condensation scheme, are perturbed by the Markov processes. Three sets of ensemble forecast experiments with different perturbation strategies are carried out. Verifications for 16 summer cases with particular emphasis on quantitative precipitation forecast (QPF) are performed. It is shown that forecasts using targeted moist SVs initial perturbations can significantly improve the scores of accumulated 24 hour precipitation in the ranges from 2.5 to 50 mm compared to forecasts with dry targeted SVs. Similarly, the forecasts with stochastic parameter perturbations in model physics along with targeted moist SVs initial perturbation can produce better scores against those with targeted moist SVs alone. Moreover, the use of the ISBA surface scheme in this REPS greatly improves QPF scores compared with the Force-Restore scheme.

4B4.1 **INVITED / INVITÉ**
Forced Annular Variations In the 20th Century IPCC AR4 Simulations
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We examine annular modes (defined here as the leading empirical orthogonal function of hemispheric sea-level pressure) simulated by the IPCC AR4 ensembles of coupled ocean-atmosphere models. The simulated annular patterns during the late twentieth-century are highly

correlated with the observed spatial pattern, though representing too large a percentage of hemispheric SLP variability. In response to increasing concentrations of greenhouse gases and tropospheric sulfate aerosols, the multi-model average exhibits a positive annular trend in both hemispheres, with decreasing sea-level pressure (SLP) over the pole and a compensating increase in mid-latitudes. In the Northern Hemisphere, the trend agrees in sign but is of smaller amplitude than that observed during recent decades. In the Southern Hemisphere, decreasing stratospheric ozone causes an additional reduction in Antarctic surface pressure during the latter half of the twentieth century. Not all models predict a decrease in high-latitude SLP, but no model exhibits an increase. As a test of the models' annular sensitivity, the response to volcanic aerosols in the stratosphere is calculated during the winter following five major tropical eruptions. The observed response results from coupling between stratospheric anomalies and annular variations at the surface, similar to the coupling between these levels simulated elsewhere by models in response to increasing GHG concentration. The multi-model average is of the correct sign but significantly smaller in magnitude than the observed annular anomaly. This suggests that the models underestimate the coupling of stratospheric changes to annular variations at the surface, and may not simulate the full response to increasing GHGs.

4C4.3
Estimating impacts of climate change on water balance for the Oak Ridges Moraine, Ontario
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The impacts of climate change on water balance are assessed under different scenarios for the Oak Ridges Moraine in the Greater Toronto Area. The simulation for estimating the water balance is performed using a process-based ecological model - the Ecological Assimilation of Land and Climate Observations (EALCO). Climate data used in the study are the outputs of climate model simulations conducted in support of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4). Selected GCM models include CCSM3.0, CCCMA3.1, ECHAM5, and UKMO-HadCM3 under the scenario SRESA2, SRESB1, and SRESA1B, which describe higher, lower, and moderate level of CO_2 Emissions. We estimate water balance change for the past and future 100 years, and compare climate impacts on water balance under different GCM models and scenarios. Our results provide the estimation of spatial distribution and temporal variations of water fluxes for each watershed in the study area. This study analyzes effects of climate change on the evapotranspiration, runoff, and drainage depending on the proportion of the evapotranspiration and runoff in future precipitation.

Key words: water balance, Climate impacts, GCM outputs, Oak Ridges Moraine.

2DPA5.6
Carbon and Water Fluxes in Young Temperate Pine Chronosequence Forests in Ontario, Canada
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Human activities in eastern North America have significantly altered the land surface. During the last 100 years a substantial portion of previously cleared land has come under natural succession and managed plantation forests. These forests are in various stages of their development. Few studies have investigated how stand-age affects the stand's water vapour and carbon dioxide (CO_2) exchange capacity, particularly in temperate conifer forests. We initiated year-round observations of energy, water vapour and CO_2 fluxes in a chronosequence (3, 16, 31, and 66 year-old) of temperate conifer plantation forests (white pine) in southern Ontario using the eddy covariance technique. These sites are known as the Turkey Point Flux Station. White pine is an important species in the North American landscape, because of its ability to adapt to dry

environments and sandy soils. We will present results of CO_2 and water vapour flux measurements over 2005. Highest evapotranspiration, about 3.5-4.5 mm per day was observed at 16-year stand followed by 31-year and 66-yr forests. Net ecosystem productivity (NEP) and water use efficiency of the 16-year stand was the highest, followed by the 31-yr, 66-yr, and 3-yr forests. We found that radiation and temperature were two dominant controls on NEP. Seasonal patterns of CO_2 uptake were further influenced by soil moisture. Our results indicate that carbon uptake and forest productivity may peak already within the first 25 years after plantation establishment. The correlation between climate variables and CO_2 exchange is important to understand impacts future climate change on forest productivity and C cycling.

2C3.3
Rectifier Effect in an Atmospheric Model with Daily Biospheric Fluxes: Impact on Inversion Calculation

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Atmospheric CO_2 measurements show strong synoptic variability. To understand the contribution of the synoptic signals on atmospheric CO_2 inversion, we simulate the cases of biospheric fluxes with and without synoptic variations using an atmospheric transport model, and then perform inversion analyses with these biospheric CO_2 fields.

Results show that synoptic biospheric signals are present in monthly and annually averaged CO_2 concentrations. The synoptic signal is a function of the distance from the continental biospheric source regions (monthly difference up to 7 ppm). These simulated synoptic CO_2 patterns are the results of the interaction of the synoptic CO_2 field and atmospheric transport, and may be referred to as the synoptic Rectifier Effect.

Inversion CO_2 fluxes for 1992-1995 are obtained using biospheric background fields with and without synoptic biospheric flux variations. Results show that the synoptic Rectifier Effect on inversion varies spatiotemporally. The maximum magnitude differences for land and ocean regions are ~0.4 and ~0.2 $GtC \cdot month^{-1}$ respectively. The average land sink increases by 0.19 $GtC \cdot yr^{-1}$ while the average ocean sink decreases by 0.30 $GtC \cdot yr^{-1}$. The synoptic atmosphere biosphere interaction has effects on the partitioning of the CO_2 sources/sinks between the land and ocean regions, as well as on their inter-annual variability.

1C3.3
An Investigation of Internal Wave Spectra

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Our incomplete understanding of physical dissipation processes within an internal wave field impacts on questions of mixing in both the atmosphere and ocean, with enormous dynamical ramifications in the case of the middle atmosphere. Efforts to solve the puzzle have centred on nonlinear interactions among internal waves, but the inherent complexity has hindered progress. Some recent publications have proposed that the complexity could be circumvented by using a Lagrangian, rather than Eulerian, formulation. We investigate this proposition with a Lagrangian wave model. Our results have important implications for certain quasilinear theories of wave spectra.

2DPA5.4

Comparison of water and carbon flux simulations in contrasting environments using different root-water uptake schemes

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Multi-year data of tower-flux measurements collected over contrasting environmental conditions were used to compare with simulations of water and carbon fluxes by an ecosystem model (IBIS), when root soil water uptake (RSWU) by vegetation is described within the model using two different schemes: a) a first scheme where the relative functional importance of roots and water stress compensation is not considered; and b) a second scheme where dynamic allocation of root water uptake is simulated thereby compensating for the water stress that is caused by a dry soil layer, by allowing more water uptake from wetter layers. The performances of the two RSWU schemes were evaluated in relatively wet ecosystems, including a Coastal temperate coniferous forest located in Western Canada (Douglas-fir; British Columbia) and a temperate broadleaf deciduous forest located in the Mid-Western United-States (oak; Tennessee), and in relatively dry ecosystems including two warm grassland areas located in Southern United-States (Oklahoma). Results show that under dry conditions, the representation of dynamic allocation of root water uptake within ecosystem models is essential for better predictions of the exchanges of water between the atmosphere and the biosphere, particularly in dry ecosystems. The use of the second RSWU scheme in IBIS yielded indeed better correlations between measured and simulated evapotranspiration (ET) rates, than the use of the first RSWU scheme. For instance, the correlation (R^2) between measured and simulated daily ET rates improved from 0.92 (1^{st} RSWU scheme) to 0.96 (2^{nd} RSWU scheme) for the temperate coniferous forest located in British Columbia (Canada), and from 0.25 (1^{st} RSWU scheme) to 0.50 (2^{nd} RSWU scheme) for the grassland ecosystem located in Little Washita in Oklahoma. The implications of our findings on carbon and water budget predictions by ecosystem models will be discussed.

4DPA6.21

Model study of reactive bromine chemistry over the springtime Arctic boundary layer with GEM-AQ

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Each spring in the Arctic there is an "explosion" of BrO into the marine boundary layer from the surface. The source of the bromine appears to be accumulated sea salt released from the snow pack or possibly via frost flowers. The BrO leads to rapid and severe destruction of ozone and it also seems to be implicated in the disappearance of gaseous Hg during ozone depletion events. In order to better understand this phenomenon we have added gas-phase bromine chemistry to GEM-AQ. The GOME instrument on the ERS-2 satellite has provided BrO column data for the troposphere, but it is not clear at what height within the troposphere the BrO is located. Thus we initialize the BrO over different layers and follow its evolution and impact on tropospheric ozone. By comparing with GOME observations at a later time we thus try to identify the height of the BrO Cloud and possibly the source region. We will also attempt to quantify the amount of BrO that can escape to the free troposphere.

4DPA8.1

Quesnel Lake Climate and Mixing: The Physical Habitat of Fish

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Quesnel Lake is a large deep lake in British Columbia and is one of the ten deepest lakes in the world. As part of the Fraser River system Quesnel Lake is an important nursery lake for Fraser River sockey salmon. We have begun work on two aspects of lake physics that affect fish and their habitat in Quesnel Lake: (1) the underwater temperature climate and (2) circulation and mixing processes that control nutrient budgets. Annual patterns of thermal stratification determine, for example, the length of the growing season, the depth of critical isotherms, habitat 'fronts' and internal thermal 'shocks", vertical (nutrient) exchange and the temperature of out-flowing river water. The latter has been observed to have large rapid fluctuations that have proven impossible to model with the IOSRTM model. The lake study is made up of a number of thermistor array moorings located throughout the lake, combined with periodic intensive study periods using CTDs, oxygen sensors, and acoustic surveys combined with nutrient sampling. Here we present preliminary results that interpreted with the help of a simple conceptual model.

3B3.3 **INVITED / INVITÉ**

An examination of the role of freshwater on the Labrador Sea

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The climate of the North Atlantic and the Arctic are linked in a number of ways. Decadal variability in ocean properties, winds, precipitation, etc. have been linked to both the North Atlantic and Arctic oscillations and to each other through feedback loops. A key feature of all these loops is the role of freshwater. In this talk, issues of freshwater in the Labrador Sea are considered from modelling studies, atmospheric reanalyses and historic oceanic data.

The transport of freshwater is analyzed in an eddy-permitting regional model of the sub-polar North Atlantic. The importance of export of Arctic freshwater through the East Greenland Current as well as the Baffin Island Current is examined. The role of eddy process and representation is also considered in the context of this question. Analysis of net precipitation minus evaporation over the Labrador Sea since 1950, from NCEP and ERA40 reanalyses are also considered. Results from both datasets are comparable (and consistent with satellite based measurements over the more recent part of the study period) and suggest a significant increase in precitation over the Labrador Sea since the mid 1970s, mainly in spring and summer. Potential linkages between changes in the atmospheric precipitation and historical sea surface salinity changes, and the great salinity anomalies are considered. The impact of these changes on Labrador Sea Water formation rates are examined using a series of water mass diagnostics.

2DPA5.1

Regional Carbon Sink/Source Information Inferred from CO2 Concentration Measurements in a Boreal Forest Region

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Many progresses have been achieved at the extreme ends of the spatial scale spectrum, either large regions/continents through atmospheric inversion or small vegetation stands through flux and ecological measurements. Because of the heterogeneity of the land surface and the nonlinearity inherent in ecophysiological processes, carbon balance estimates at regional scale are comparatively weak. We seek ways in this study to retrieve regional carbon balance information from atmospheric CO_2 concentration measurements.
The CO_2 data record over 14 years (1990-1996, 1999-2005) measured on a 40-m tower at Fraserdale, northern Ontario, Canada ($49^0$52'29.9''N, $81^0$34'12.3''W) provides an opportunity to study regional carbon sink/source information cross seasonal to inter-annual time scales. We

approximate the difference in CO_2 (ΔC_{FT-PBL}) between the free troposphere (FT) and the mean value in the well mixed planetary boundary layer (PBL) as a proxy of regional carbon flux. ΔC_{FT-PBL} shows considerable seasonal and inter-annual variations. Data analysis also reveals that ΔC_{FT-PBL} was sensitive to temperature: larger values of ΔC_{FT-PBL} are found in the warmer growing seasons and warmer years, indicating larger sinks in the boreal forest region in warmer conditions. This suggests that the photosynthetic carbon uptake increased more than the respiratory carbon release as the temperature increased. Both the direct (photosynthesis temperature sensitivity, growing season length) and indirect (nutrient cycling) effects of temperature increase on plant growth might have contributed to this large photosynthetic temperature sensitivity.

4C3.5
DMS Oxidation to Sulphur Dioxide, Aerosol Sulphate and MSA during C-SOLAS and the Role of Isotope Apportionment

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Dimethylsulfide (DMS) oxidation must be well defined in order to correctly estimate the effect it has as a climate feedback to global warming. DMS released to the atmosphere is largely oxidized to sulphur dioxide, sulphate and methanesulphonic acid (MSA). Its oxidation pathways are influenced by NOx concentrations, pre-existing aerosols, as well as atmospheric temperature. Oxidation that results in newly formed cloud condensation nuclei is the parameter that must be quantified to accurately model the effects on regional or global radiative balance. To better define DMS oxidation, a unique series of atmospheric measurements were performed as part of Canadian Surface Ocean Lower Atmosphere Study (C-SOLAS) to identify sulphur dioxide and sulphate from DMS in size segregated and total aerosol. Aerosol composition, including MSA and sulphate, as well as SO_2 and DMS were analyzed for a total of four shipboard campaigns in the Pacific and NW Atlantic in 2002 and 2003. Land-based measurements downwind of the Pacific study on the west coast of Vancouver Island provide a larger context in which to place the ship-based measurements. Sulphur isotope apportionment was used to quantify the contribution of DMS to sulphate and sulphur dioxide to link gas concentrations with biogenic aerosol formation. Highlights from this study include DMS mixing ratios of 8 ppb in air and the potential for BrO oxidation of DMS during the Pacific study, consistent biogenic SO_2 concentrations and large variability in MSA/NSS over the NW Atlantic as well as the first isotope measurements of MSA. Comparison of DMS flux based on a steady-state atmospheric oxidation model, and flux calculated from DMS concentrations collected coincidentally in surface waters will also be presented.

2C4.1
Mapping drought indices in forecast mode in western Canada

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Drought mapping with real or near real time climate data is routinely done as means of reporting emerging risks. It provides useful information on the spatial extent of the drought risk and may indicate the start and end of the risk. From a preparedness point of view, very little can be done in

the middle of a drought. If the risk is known ahead of time, some advanced planning in terms of strategies of coping with a drought could be put in place. An attempt was made in this study to demonstrate how drought indices can be generated in forecast mode from climate and forecast data. The National Drought Model (NDM), currently used to monitor drought in near real time was run in forecast mode using climate and forecast data as inputs. Probability distributions of the drought indices (Palmer Drought and Standardized Precipitation Index) were then generated. The likelihood of being in a drought or flood was enhanced in those years with higher than average skill scores in the forecast. The study showed that using climate, now casting and forecast data, useful information can be obtained on the probability of the drought risk. This information can be applied for risk aversion in weather sensitive operations such as agriculture.

2DPA6.12
Simulated changes in the atmospheric "tape recorder" under global warming
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The annual cycle of entry values of water vapour in the tropical lower stratosphere can be followed for over a year from the tropopause up to 10 hPa (33 km), and for this reason has been termed an atmospheric "tape recorder." This observed phenomenon is studied using a recently modified version of the CCCma atmospheric general circulation model (AGCM3+) coupled to a mixed layer ocean. In present-day simulations, the upward propagation of the stratospheric entry values of H_2O and total hydrogen ($H = 2CH_4 + H_2O$, an approximately conserved quantity in the mid- to upper stratosphere) imply an annual mean vertical upwelling velocity of 0.2-0.3 mm/s between 100 hPa (16 km) and 60 hPa (20 km), values in good agreement with HALOE satellite measurements over the last decade. A number of simulations of future climate were also performed, in order to gauge the response of the model tape recorder to atmospheric composition and circulation changes associated with increased greenhouse gas concentrations. These simulations show both an increase in the amplitude of the tape recorder signal and a slight increase in the upwelling velocity of H anomalies, consistent with other work suggesting an intensified Brewer-Dobson circulation in a warmer world.

2C2.2
Forecast Errors Associated with Hurricane Rita (2005)
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The 2005 hurricane season in the Atlantic Basin broke numerous records for frequency, intensity, and duration of storms. Seven storms reached major hurricane status, with four storms making landfall along the United States coastline at category 3 intensity or higher. In the case of Hurricane Rita, a dramatic shift in the post-landfall forecast track occurred about 24 h before landfall on September 22. Previous to this time, model consensus was for the storm to stall over the Texarkana region for several days, resulting in the expectation of heavy flooding in this region. In contrast to those forecasts, the bulk of the precipitation associated with Hurricane Rita began to accelerate poleward after landfall, impacting regions of southern Canada and the northeastern United States within 36 to 48 h after landfall.
Preliminary results suggest the primary mechanism responsible for this dramatic change in forecasts centers around an extratropical low pressure system centered several hundred kilometers to the north-northwest of Hurricane Rita. The intensity of this system was almost universally under-forecast by the numerical guidance. Concomitantly, the upper-level ridging associated with Rita was over forecast, perhaps due to the failure of the numerical guidance to capture the response to the weakening of Hurricane Rita prior to landfall. The combined effects of these two errors was to produce a forecast of weaker steering flow over the storm versus verification.

4DPA7.9

Radiative Influences on Sulphate, MSA and Sulphur Dioxide Formation via DMS Oxidation

Michelle Seguin [1] , Ann-Lise Norman [1] , Moire Wadleigh [2] , Astrid Siauw [1] , Sarah Eaton [2]
(Presented by / Présenté par ***A. Michelle Seguin***)
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Dimethylsulphide (DMS) is released from the surface ocean and follows different oxidation pathways to produce methanesulphonic acid (MSA) and SO_2 in the atmosphere. Sulphur dioxide can further be oxidized to form new sulphate aerosols that act as cloud condensation nuclei. Diurnal aerosol samples and size segregated samples as well as atmospheric SO_2 and DMS measurements were taken during the summer 2003 Canadian Surface Ocean Lower Atmosphere Study (C-SOLAS) cruise over the North Atlantic. Aerosol samples and SO_2 can be traced back to their origins using stable isotope techniques.

Fog and drizzle were present during many days of the cruise. Samples from overcast and clear sky days were compared in order to better understand the oxidation pathways of DMS under these varying conditions. Concentrations and isotope characteristics before and after precipitation events were studied to determine the effects of rainout. Total atmospheric sulphur dioxide concentrations were as high as 12,000 ng m^{-3} during the summer in contrast to 1900 ng m^{-3} during a similar cruise in spring 2003. Night and day samples were compared to explore the effects due to radiative influences.

3B2.1 **INVITED / INVITÉ**

An updated assessment of stratospheric temperature trends

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An updated assessment of stratospheric temperature trends is ongoing under the SPARC program Detection, Attribution and Prediction of Stratospheric Change. This project will include an update of observed global temperature changes observed by satellites, radiosondes and lidar measurements, and assessment of uncertainties (Phase I), followed by extensive comparisons with various model simulations, including results from CCMval (Phase II). This talk will highlight updated observations of temperature variability and trends (including data through 2005), and discuss intercomparisons among the different data sets. We will also show some brief comparisons with model calculated temperature trends.

3DPA5.6

An analysis of water mass variability in the Labrador Sea

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Labrador Sea Water (LSW) is formed through a process known as open ocean convection, and the rate of formation is regulated by the atmosphere-ocean interactions. The newly formed LSW is advected out of its formation basin, the Labrador Sea, and carries the atmospheric signatures embedded within to other parts of the World Ocean. In this study, the links between some of the most prominent atmospheric and oceanic state parameters, such as salinity, mixed layer depth, North Atlantic Oscillation (NAO) index, and evaporation/precipitation budgets are discussed. A time series of sea water salinity and temperature are obtained by objectively mapping the three-year running means of the historical data collected between 1949-1999. As opposed to working with geopotential levels (i.e. fixed depth intervals), a more natural coordinate system (isopycnal

surfaces) in the vertical is employed. The use of isopycnal coordinates, together with an objective analysis scheme that takes into account the fundamental flow structure, lessens the negative effects of over-smoothing introduced during the interpolation of unevenly distributed observations onto regular grids. Current velocities and volume fluxes are calculated from a diagnostic model are used to estimate the role of cross-shelf freshwater transport on the long-term freshening of the LSW and formation rates.

4DPA7.10
Source Apportionment of Sulphate Aerosols and Sulphur Dioxide During the Spring 2003 over the North Atlantic
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Sulphate aerosols have the potential to alter climate, reducing the effect of increasing greenhouse gas emissions by scattering incident solar radiation back to space. Dimethylsulphide is emitted from the surface ocean, and oxidized into methanesulphonic acid aerosols, or gaseous sulphur dioxide (SO_2) in the atmosphere. SO_2 can be further oxidized forming new sulphate aerosols. During the spring (2003) cruise of the NW Atlantic, as part of the Canadian-Surface Ocean Lower Atmosphere Study (C-SOLAS) size segregated and total particulate sulphate aerosols and gaseous SO_2 samples were collected. Samples were collected diurnally using mass flow-controlled, high-volume air samplers. The cruise consisted of a Lagrangian study and a Transect study from 36ºN to 54ºN. Aerosol and SO_2 samples were characterized isotopically and for their chemical composition.

The spring SABINAdata set had concentrations of SO_2 and aerosol NO_3 which were higher than previously reported. Increased NO_3 concentrations allow for increased oxidation of biogenic and anthropogenic SO_2. Previously unreported negative sulphur isotope values for non sea salt sulphate were found and have been attributed to the combustion of Middle Eastern oil at a refinery in Newfoundland.

Anthropogenic SO_2 concentrations were higher than anthropogenic SO_4^{2-} concentrations. Biogenic SO_2 concentrations were relatively constant throughout the research cruise; in contrast to biogenic SO_4^{2-} concentrations which were highly variable. The isotope composition and concentration of SO_2 and non-sea salt sulphate were compared to the elemental and ionic composition of the aerosols. No relationship was found but an interesting pattern was apparent with phosphate concentrations. Significant diurnal differences were apparent in aerosol PO_4^{3-} concentrations ($F_{(1,33)} = 81.9$, $p < 0.001$), with higher concentrations in northerly waters.Increases were potentially related to colder water masses and colder atmospheric temperatures, leading to a shift in the production and/or removal of PO_4^{3-}.

4C2.1 **INVITED / INVITÉ**
Internal Solitary Waves in the Coastal Ocean: Generation, Energetics and Dissipation
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Internal solitary waves are highly energetic events that are ubiquitous in coastal ocean regions. In this talk I begin with an overview of internal solitary waves. This will be followed by a discussion of the wave generation process and an examination of the energetics of internal solitary wave trains. The talk will end with a discussion of numerical simulations of breaking waves in tilting tank experiments conducted by L. Boegman and G. Ivey.

1C1.2

Mapping surface soil moisture and roughness using multi-angle radar imagery without ancillary data

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Information about the distribution of surface soil moisture can greatly benefit the management of agriculture and natural resource. However, direct measurement of soil moisture over larger areas can be impractical and expensive, which has led scientists to develop satellite based remote sensing techniques for soil moisture assessments. Retrieving soil moisture from radar satellite imagery often associated with the collection and use of ancillary field data on surface roughness. However, field data that is meant to characterize surface roughness is often unreliable, is expensive to collect and is nearly impossible to acquire for large scale applications. These issues represent barriers to the adoption and of radar data for mapping soil moisture over large areas. The research presented in the paper is aimed at the development of an operational soil moisture assessment system based solely on radar satellite data and a radar model, eliminating the field data requirements altogether. The study develops methodology and demonstrates its implementation to estimate both soil moisture and surface roughness without the use of ancillary field data. Validation results conducted in Arizona showed that the proposed method is capable of providing more precise estimates of surface soil moisture than that of ancillary field-data supported method. Results also showed that radar images can provide estimates of surface soil moisture at the watershed scale with good accuracy. Results at the field scale were less accurate, likely due to the influence of image speckle.

1C1.4

Marine Wind Retrieval using Radarsat-1

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The assimilation of synthetic aperture radar (SAR) data into models depends partly on whether errors in SAR-wind information can be quantified as well as on the identification of conditions for which forecasts can be improved. Error estimates for the surface winds retrieved from Radarsat-1 SAR backscatter cross section are derived using nonlinear regression. The SAR-wind relationship employed is the European Remote Sensing (ERS) C-Band model (CMOD) and the polarization ratio of Vachon and Dobson (2000). Background (first-guess) winds for SAR acquisitions along the eastern and western North American coast are obtained from a high-resolution version of the Global Environmental Muliscale (GEM) model. Bias and variance of the errors in backscatter cross section, relative to those of the GEM model winds, are iteratively estimated and used to combine these two data. Differences between the resulting retrieved winds and in situ observations are examined under different environmental and imaging conditions.

2B3.5

Effects of Isotopic Disequilibrium on Vertical Distribution of δ13C of CO2 in the Planetary Boundary Layer over a Boreal Forest Region: Multi-temporal Scale Perspective

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Ecosystem exchange of carbon isotopes with the atmosphere is correlated diurnally and seasonally with the planetary boundary layer (PBL) dynamics. The strength of this kind of covariation affects the vertical gradient of (^{13}C and thus the global (^{13}C distribution pattern. The (^{13}C of current photosynthetic fixation is usually different from that of respired CO_2. This isotopic disequilibrium must reflect on (^{13}C distribution pattern. If we understand the mechanism of isotopic disequilibrium affecting the vertical distribution of $\delta^{13}C$ of CO_2, the use of (^{13}C as an additional constraint to identify various carbon sources and sinks can contribute to a significant reduction in the uncertainty in regional carbon budget estimation. In this study, we employ a one-dimensional ecosystem–boundary layer isotope model to investigate the disequilibrium effects on $\delta^{13}C$ dynamics in PBL over a boreal forest region in the vicinity of the Fraserdale tower (49°52′29.9″N, 81°34′12.3″W) in northern Ontario, Canada. The data from intensive campaigns at this site are used for model validation and a 13-year (1990-1996, 1999-2004) hourly averaged air CO_2 concentration record and meteorological data measured on this tower are used for this investigation. The interaction between the biosphere and the atmosphere with respect to $\delta^{13}C$ is examined. The vertical gradient of $\delta^{13}C$ results not only from the net CO_2 exchange with the surface but also from the isotopic disequilibrium of respiration and photosynthesis. This disequilibrium effect is found to vary diurnally, seasonally and inter-annually, and to correlate with air temperatures and relative humidity.

3B4.5
Seasonal Comparisons of Strong Western North Pacific Cyclones and the SST Anomalies Beneath Them
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Prompted by an unexplained atmospheric phenomenon over the North Pacific Ocean, called the midwinter storm track suppression, the hypothesis of a seasonal variation in the role of surface heat and moisture fluxes in small groups of strong western North Pacific cyclones is examined. Their net effect is first examined using SST anomalies as a proxy. Composite SST anomalies are constructed for each cyclone group, where groups are defined only by the occurrence of events during midwinter or during the early and late cold season. Systematic differences in sea surface temperature anomalies beneath these two groups are interpreted as differences in preconditioning by the upper-oceanic mixed layer. Extended-range atmospheric simulations are performed to examine the possible influence of cold SST anomalies on early and late cold season cyclones.

4DPA6.25
Improving Global Bottom-Up Inventories of Biogenic Soil Emissions
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Nitrogen oxide radicals ($NO_x \equiv NO + NO_2$) largely control the production of tropospheric ozone. Emissions of nitric oxide from soils remains one of the most uncertain NO_x sources. Top-down constraints on soil NO_x emissions from the Global Ozone Monitoring Experiment (GOME) satellite

instrument provide evidence that current bottom-up inventories are underestimated by 70%. This work focuses on developing an improved bottom-up inventory of soil NO_x emissions for use in global models. Presented here are various improvements to the bottom-up inventory, including the implementation of a current agricultural fertilizer dataset with seasonal variation of application inferred from land cover observations from the MODIS satellite instrument, and an emission algorithm that depends explicitly on soil moisture, with particular attention being paid to the African Sahel. The resultant bottom-up inventory will be compared with nitrogen dioxide measurements from GOME.

2C3.7

The CCCma Global Coupled Climate-Carbon Model: Initial Results

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(Presented by / Présenté par ***Gregory Flato***)

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The Canadian Centre for Climate Modelling and Analysis (CCCma) has been working in collaboration with University colleagues to develop terrestrial and oceanic biosphere components that allow CO2 to be modeled as a prognostic variable that is function of the simulated climate. In parallel, the treatment of methane in the CCCma model has also been improved, including time-dependent CH4 emissions from 1850 to 2100. Modelling land-atmosphere exchange of CO2 requires simulation of vegetation as a
dynamic component whose structural attributes change in response to changes in model climate. The newly-developed Canadian Terrestrial Ecosystem Model (CTEM) provides this functionality. A series of offline tests in which CTEM is driven with observationally-based and model-derived climate data illustrate its suitability as a dynamic vegetation component of the CCCma climate model. The Canadian Model of Ocean Carbon (CMOC) provides corresponding functionality for the ocean and it has also undergone extensive offline testing. CMOC simulates the preindustrial state well, and simulations with enhanced CO2 concentration are presently underway. Initial results from these experiments, and plans for the future, will be discussed.

3B2.3

The CMAM Transient Simulations for CCMVal: Chemical overview of Antarctic Ozone Depletions

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The Canadian Middle Atmosphere Model (CMAM) has been used to produce a three-member ensemble of transient simulations charting the evolution of the ozone layer from pre ozone-hole conditions, through the development of the Antarctic ozone hole in the 1980s, and towards eventual recovery in the middle of the 21st century. This set of simulations form the CMAM contribution to the Chemistry Climate Model Validation Activity for SPARC (CCMVal) and the next WMO Ozone Assessement. An overview of the model simulation of historical and projected concentrations of Cl in the lower stratosphere and the evolution of ozone depletion events over Antarctica will be presented. Particular attention will be paid to how the CMAM model simulates the processing of Cl on polar stratospheric cloud particles during the polar winter and spring and the interrelationship between chemical and dynamical processes on the interannual variability of the ozone hole.

1DPA2.12
Vertically resolved middle atmosphere chemical variability derived from space-based observations, and comparison to a coupled chemistry-climate model.
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Accurate quantification of the natural variability of stratospheric chemical species is crucial for the detection of trends using temporally sparse observations, and for the use of temporally or spatially distant measurements in instrument validation exercises. Satellite observations of stratospheric chemical species made with high precision and good vertical resolution by the state-of-the-art satellite instruments ACE-FTS and EOS-MLS are used here to estimate the natural short-term, small-scale variability of relatively long-lived species (including O3, N2O and HNO3), through a method that separates estimates of instrument uncertainty from natural variability. Atmospheric models that integrate current understanding of atmospheric dynamics and chemistry, such as the Canadian Middle Atmosphere Model (CMAM), provide a theoretical estimate of the natural variability. The vertically resolved estimated natural chemical variability profiles estimated from the observations are compared to predictions based on output from the CMAM, as a test of the agreement between model and observations.

3DPA3.4
Observation of ship plumes and their evolution in Great Vancouver area
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There is increasing concern regarding the impact of marine vessel emissions on the air quality of coastal areas and their relative impact is increasing as emissions from other sources decrease and shipping activities increase. Marine vessels commonly operate on large diesel engines with heavier fuels of high sulphur content. Their exhausts contain many pollutants at high concentrations and present a potential risk to the population residing in areas near the port.

During the PAC2001 field study in Vancouver, several suspected ship plume events were observed at a site ~5km inland. One such event was characterized with detailed information on gaseous and particulate pollutants, such as the concentrations of different gases and particulate material(PM), the main sizes of the particles and the basic chemical composition of PM (organic, sulphate and nitrate). Also noticed was possible formation of SO4 on surface of particles in presence of H2O.
In the summer of 2005, we returned to Vancouver with our mobile lab CRUISER equipped with a suite of instruments including AMS, PTRMS, Photo-Acoustic, gas monitors (NO/NOx, SO2, CO and O3) and others. One of our objectives is to track plume evolution in greater detail and to compare ship plume with the emissions from other sources. On two separate occasions, a distinct plume from a ship at berth was detected and measured by CRUISER at multiple points along the wind flow path.

In this presentation we will describe these new results and compare them with what was observed in 2001.

2C2.3
Severe Winds associated with Typhoon 200418 around Hokkaido, Japan
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Typhoons occasionally bring severe damages in the higher latitudes due to an interaction with the upper level short-wave trough. The case that severe winds hit Hokkaido, Japan associated with Typhoon 200418 on September 8, 2004 is one such example. Instantaneous maximum winds were recorded over 50 m/s in Sapporo. The strongest one was 51.5 m/s at Ohmu in the northern Hokkaido. The damages caused by the strong winds were approximately 51.2 billion yens (about 45 million US dollars) in total, 8 people were killed and 121 people were injured just in Hokkaido. Typhoon 200418 accelerated towards the north over the Sea of Japan and the cloud structures drastically changed in the middle of the night of September 7 due to the dry air intrusion associated with an upper-level short-wave trough. The synoptic data shows severe winds were occurring from south to north in western Hokkaido. The wind speed variations were large during the strong winds. Overall, the air temperature increased and dewpoint temperature decreased. However, on a convective timescale the air temperature decreased. There was no precipitation by rain gage but precipitation sensor detected. The wind profiler showed that the upper level stable air (clear echo) was gradually descending before the severe wind occurred. The vertical component of Doppler velocity data showed that downdrafts occurred several times from the upper level during severe winds. These facts show that the upper level dry air associated with a jet and a short-wave trough evaporated the clouds and precipitation particles of the typhoon, the air was cooled down and downdrafts took place. The severe winds occurred intermittently due to the divergence of the wind on the ground.

1C4.1
On Drifting and Blowing Snow in high latitude regions
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Climate analyses, weather observations and forecasts and specialised field measurements, not to mention local knowledge, confirm that at high latitudes in winter there are frequent drifting and blowing snow events. All suggest that over ice or tundra in winter, snow particles are in motion between 20 and 30% of the time. The phenomenon includes saltating snow particles near the ground and suspended particles to eye level and above. Criteria for occurrence, and for significant visibility reductions will be reviewed and threshold criteria evaluated. Different measurement approaches will be discussed based on field measurements from Churchill airport and over ice in Franklin Bay, with a focus on particle counters based on the Brown and Pomeroy design.

1DPA4.10
Spectral analysis of internal waves generated by tidal flow over topography
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The primary goal of this work is to provide a description of the energy cascade in internal waves generated by tidal flow over topography.We have carried out several sets of numerical experiments to model the dynamics of the velocity field in the deep ocean. A two-dimensional finite volume model solving the nonhydrostatic equations of motion was used. The experiments were performed for different latitudes and various types of topography. Thorough spectral analysis of the obtained data including error estimation was performed. In particular, the evolution of the two-dimensional spectra for the developing flow was calculated. The spectra of the time-series associated with points fixed in Lagrangian and Eulerian reference frames were also computed. The results were compared to several previous works in the field. Some new features of the energy cascade were found. The distinction between most of the previous works and our lies in the way we model the bottom forcing. In our simulations we explicitly consider the wave

generation process by introducing topography rather than approximating it with specific boundary conditions or force terms in the governing equations.

2C3.2
Use of remote sensing data and geostatistical inverse modeling for quantifying processes controlling the spatial and temporal variability of carbon fluxes
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Recent rates of increase of atmospheric CO2 suggest that the biospheric uptake of CO2 has increased as anthropogenic emissions have grown. There is debate, however, about the exact feedbacks controlling this uptake and its geographical distribution. Whereas biospheric models can parameterize the various components of the carbon cycle, they cannot always reproduce the observed global atmospheric CO2 distribution. Inverse modeling methods, on the other hand, use this distribution as a constraint, but typically solve for flux magnitudes, providing little or no process-based information. The availability of satellite-derived remote-sensing biospheric data and the recent development of geostatistically-based inverse modeling tools provide a new opportunity to combine the best features of the above two approaches, and improve understanding of the processes controlling the carbon cycle. In the presented work, the geostatistical approach is used to determine the influence of remote sensing biospheric, land cover and meteorological data on global monthly-averaged carbon flux estimates for 1997 – 2001, on a 3.75o x 5.0o scale. This setup has the ability to quantify the effect of these data on CO2 fluxes without assuming a priori the magnitude or statistical significance of the correlation of these data with the inferred carbon fluxes. This method thereby offers a possibility to both estimate surface fluxes of CO2 that are consistent with observed atmospheric distributions, and directly provide insight into the biospheric processes controlling fluxes. The set of statistically significant auxiliary variables includes LAI, fPAR, population density, and certain land use categories. Results are compared to previous carbon dioxide inversion studies and to flux distributions obtained from biospheric models.

1B2.1
The NinJo Workstation Project
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The Meteorological Service of Canada is building a workstation application that integrates and displays all data. It is looking for a system that can be extended in the future. After reviewing existing workstations both internal and external, the MSC was able to join the NinJo project. NinJo was being developed by the German Weather Service, the Danish Meteorological Institute, MeteoSwiss and the Bundeswehr Geophysical Services. There were mutual benefits and requirements. All the partners, and indeed many other nations, had reached the end of the lifespan of existing workstations due to unavailability of hardware and the cost of maintaining/transporting the software to some other platform. The decision to join the NinJo project was based on its potential feature set, to integrate data applications, to be extended, among others. This is also a major opportunity to rejuvenate forecasting with the MSC from science to products. It will be the focus of technology transfer, the forecast systems lab and a link to the National Labs. The presentation will review the myriad of activities and status of the project.

4B1.1 **INVITED / INVITÉ**
Observations and Interpretations from Recent Carbonaceous Aerosol Measurements in Canada
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Interest in the carbon fraction of atmospheric particles (carbonaceous aerosols) has heightened in recent years because there are critical environmental issues that depend upon our scientific understanding of their formation, behaviour and impacts. This includes climate and visibility for which the RH-dependent optical properties of carbonaceous aerosols and/or their influence on cloud formation and microphysics are important. Human health and toxic deposition are also key issues where carbonaceous aerosols play a role. For all the issues, improved understanding of aerosol size, composition, gas-particle partitioning and surface chemistry is needed.
Several field studies examining carbonaceous aerosols have been conducted in Canada during the past 5 years. These involved: multi-year time series of 24h integrated organic and elemental carbon (OC/EC) measurements; short term intensives of OC/EC separating day and night periods and semi-volatile from non-volatile OC; bulk samples for organic speciation and more-recently; time-resolved measurements of size and composition using the Aerodyne Aerosol Mass Spectrometer. In terms of OC, which typically accounts for 40-60% of the fine particle mass, two of the key air quality questions are: *What fraction of the organic $PM_{2.5}$ is secondary vs. primary and within each, what fraction is natural vs. anthropogenic?* Although a single quantitative answer remains elusive, the field work has provided some insight. In this presentation some of these results will be discussed. This includes information on the characteristics and behaviour of primary and secondary organic aerosols and contributions from some sources such as motor vehicles.

1DPA2.2
Improve Single Doppler Radar Assimilation System from Background Term
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The background term is as important as the observation term in data assimilation. By assuming the error covariance of control variables is isotropic and homogeneous, we have successfully applied recursive filter methods to the McGill single Doppler radar data assimilation system. The results show that if we consider the background error covariance properly, then there is no longer a need for the penalty (smoothness) term in the cost function. In addition, to estimate the environment field, using the previous high-resolution model forecast to be the background field in the background term is better than using the linear wind analysis. Combining previous MC2 model forecast with radar observations, one expects to get better initial condition at convective scales and extend the short-term forecast longer than 1 hour.

4C4.6
Climate change and extremes in northern Canada: Statistical downscaling results using two driving coupled GCMs
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Statistical downscaling is one possible approach to relate the large scale climate variables with local or station scale observations to obtain near surface climate information at high resolution. This study investigate the most widely used regression-based statistical downscaling model (SDSM) with respect to its potential to reproduce the mean values as well as probabilities of extreme temperatures in the reconstruction of local observed climate, in some specific locations in northern Canada. Two series of climate predictors derived from two coupled global climate models (GCMs), namely the Canadian CGCM2 and the HadCM3 from UK, are also used to construct climate scenarios information for this region, in using A2 and B2 SRES emission scenarios. The results demonstrate that the statistical downscaling model is able to capture the major part of the climate change signal, with a plausible climatic regime for higher warming both in winter than in summer and in A2 than in B2 runs. Without using the low level air temperature of

the GCMs (which is strongly biased) as a predictor, the study suggests that the combination of relevant atmospheric predictors is able to take into account most key factors of the climate change signal. The downscaled results suggests a more consensual and physically-plausible signal in all downscaled series by comparison with CGCM2 and HadCM3 raw data anomalies. This study reinforces that the confidence in local climate change information has not only related to the use of a wide range of emission scenarios and/or specific methods (GCMs or all downscaling methods both dynamical and statistical ones) and their assessments, but also to the scrupulous analysis of the simulated climate regime and its temporal and spatial distribution, as reliability and relevance at the scale of interest are required for all impact models and studies.

3C1.4

Initial results from the Walsingham VHF windprofiler radar and plans for the O-Q Net

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Our overall objective in the O-Q net is to establish a network of windprofiler radars within Ontario and Quebec, to demonstrate the usefulness of such a network to weather forecasting and atmospheric science. The University of Western Ontario Clovar windprofiler, and the McGill VHF windprofiler radar at McDonald College in Montreal have been operating successfully for some time and are a part of the net. The Walsingham radar is the first of a series of up to nine additional windprofilers that are being built and installed with a CFI grant.

VHF radars, using frequencies in the range 40 to 55 MHz can largely avoid the problems related to signal contamination due to birds and insects and also reduce the contamination which can occur due to precipitation. In the past this frequency band has been avoided, because VHF radars cannot normally measure below about 1.5 km in altitude, but recent developments have shown that with the right choice of antennas, and the correct method, measurements as low as 400 m altitude are possible and provide detailed profiles through the upper part of the boundary layer.

Recent data from the Walsingham site will be used to illustrate the capabilities of these windprofilers and the near real-time displays that can be distributed over the web. (see http://www.yorku.ca/pat/O-QNet/Walsingham/)

4DPA6.9

The Chemical and Physical Evolution of Ship Plumes as They Move Across Vancouver

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There is concern regarding the impact of ship emissions on the air quality of coastal areas and their relative impact is increasing as emissions from other sources decrease and shipping activities increase. Marine vessels commonly operate large diesel engines with heavy, high sulphur fuels. Consequently, their exhaust contains high concentrations of NO_x, CO, VOCs and particles, which pose a potential health risk to the population residing in port areas. During the Pacific 2001 field study in Vancouver a ship plume impacting upon a site ~5km inland was studied in detail. Ultrafine (<100 nm) sulphate particles was one of the most unique features of

this plume, which also contained significant amounts of ultrafine particulate organic matter. During this event, the same portion of the plume moved over the site twice separated by about three hours. This provided a direct observation of nighttime gas-to-particle conversion of SO_2. In the summer of 2005, we returned to Vancouver with a new mobile lab, CRUISER, to study ship plume impacts in more detail. On two separate occasions a distinct plume from a ship(s) at berth was detected and followed inland for up to 7 km. The suite of instruments on CRUISER was expected to provide an additional opportunity to understand how plumes evolve as they move across Vancouver and the extent of the area impacted by the port. In this poster we will describe these new results and compare them with what was observed in 2001.

4DPA7.7

The role of planktonic community respiration in biogenic carbon and climate-active gas cycling in the Northwest Atlantic Ocean

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The net flux of CO_2 and other climate-active gases between the ocean and the atmosphere is influenced by upper-ocean biogeochemical cycles, as well as food web structure and processes. The dominant food web processes include the uptake of carbon by phytoplankton during photosynthesis, its remineralization back to CO_2 through community respiration, and the export of biogenic carbon from the euphotic zone to depth. Bacterial respiration can constitute a large proportion (~ 40 to > 90%) of total community respiration, and thus may constrain estimates of both carbon remineralization and export, and ultimately, air-sea fluxes of CO_2. As part of the Canadian Surface Ocean Lower Atmosphere Study, we determined bacterial and community respiration rates in five biogeochemical provinces of the Northwest Atlantic Ocean during the spring, summer, and fall of 2003, and related these to a number of concurrently measured ecological and chemical parameters. Seasonal and spatial patterns of bacterial and community respiration are linked with temperature and a combination of biological and physicochemical forcings.

1B1.5

GEO - (Group on Earth Observation)

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GEO is a newly formed international organisation, with participation from 60 countries and 40 international organisations. Its purpose is to build a comprehensive, coordinated and sustained Global Earth Observing System of Systems within the coming decade. This talk will review recent developments with respect to this international effort, and discuss the Canadian approach and contribution to GEO.

GEO est une nouvelle organisation internationale regroupant quelque 60 pays et 40 agences internationales. Son objectif est de construire, au cours des 10 années à venir, un Système de systèmes d'observation globale de la Terre qui soit complet, coordonné et soutenu. La présentation passera en revue les récents développements concernant cet effort international et décrira l'approche canadienne et la contribution du Canada à GEO.

1DPA1.2

HURSWIM : a way to get more realistic simulations from the operational wave and storm surge models in presence of a hurricane

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Last year, we presented our work to blend a parametric hurricane surface field into the CMC forecast surface wind field with the help of a coupled system including a feeder program call SWIM (Surface Wind Interpolator and Modifier). Briefly the purpose of such an insertion is to insure at least a realistic representation of the hurricane wind and pressure fields when the operational model fails either in the positioning and/or the intensity of the vortex. Moreover, despite the improvement of numerical models and mainly because of the highly unpredictable nature of hurricane tracks, it is likely that human intervention will always be needed to correct the given numerical wind field used as input for wind-driven models such as those used for waves or storm surges. Work is in progress to make HURSWIM (the hurricane blending process) operational for the next hurricane season. Results from a coupled system of HURSWIM and WAM and those from HURSWIM and a storm surge model for a few past hurricane cases will be presented for both models.

2A1.1
The Stratosphere and Climate
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The paradigm of a separate stratosphere and troposphere is advantageous when describing quantities such as humidity, ozone, lapse rate, and potential vorticity. However, the continuous atmosphere allows vertical wave propagation, exchange of mass, and other interactions between these layers. In many respects the distiction between the stratosphere and troposphere is artificial. The dynamical coupling of the stratosphere and troposphere is primarily mediated by waves that propagate upwards, into the stratosphere, where they dissipate causing variability of the stratospheric flow.

The conventional view is that of a one-way interaction in which tropospheric waves drive stratospheric variability. Recently, this view has given way to a more sophisticated understanding of a two-way interaction Observations and model studies show that the stratosphere organizes chaotic wave forcing from below to create long-lived charges to the stratospheric circulation. These stratospheric changes can feed back to affect weather and climate in the troposphere.

Another recent development is an understanding that planetary wave propagation into the stratosphere depends not just on the phase and amplitude of tropospheric waves, but mostly on the configuration of the stratosphere. The details of planetary wave propagation and dissipation are complex, and predictions of future climate rely on models that simulate these waves.

There are three primary areas in which stratosphere-troposphere coupling is important: 1) extended-range weather forecasts, 2) climate predictions, and 3) predictions of the evolution and recovery of the ozone layer. In this talk, I will provide an overview of stratosphere-troposphere coupling and discuss aspects of these three topics.

1B1.1 **INVITED / INVITÉ**
Monitoring of atmospheric pollution from space: potential of the IASI-METOP mission
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In the recent years, several satellite missions measuring the thermal infrared radiation in a nadir viewing geometry from low orbiting satellites (IMG, MOPITT, AIRS, TES) have demonstrated the capabilities of such measurement technique for global monitoring of atmospheric composition. Combining high spectral resolution with improved spatial and temporal coverage for more accurate view of regional and local pollution will be the major objective of future missions. The Infrared Atmospheric Sounding Interferometer (IASI) is a nadir viewing FTS recording high resolution IR spectra with a daily global coverage and a 25 km horizontal sampling. IASI is an instrument mounted on the European Polar System METOP satellites. Three successive platforms will be launched sequentially over a period of 14 years, starting in June 2006, allowing the monitoring of the evolution of the composition of the atmosphere.

The capabilities offered by the IASI/METOP mission for the monitoring of trace gases in terms of accuracy, and vertical/horizontal/temporal sounding ability will be presented. The tools developed in the framework of the IASI mission have been applied to the analysis of IMG data, and results obtained for O3, CO and HNO3 will be discussed.

We will mention future plans currently under definition at Eumetsat, including the observing system experiments undertaken for the Meteosat Third Generation InfraRed Sounder (MTG-IRS), which is currently being studied as part of a suite of instruments for the future European meteorological satellites in geostationary orbit. MTG data is expected to be available 2015 - 2030.

3DPA2.1
An atmospheric wave propagation study using SATI
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To investigate the MLT (Mesosphere and Lower Thermosphere) region, a ground-based instrument called SATI (Spectral Airglow Temperature Imager) has been developed. The SATI instrument was installed and has monitored the polar MLT region at Resolute Bay (74.68^{o}N, 94.90^{o}W) since November, 2001. This is a pre-cursor experiment for the installation of a SATI that will become part of the PEARL observatory at Eureka (80.1^{o}N, 86.2^{o}W) in 2006. SATI measures the emission rate and the rotational temperature of the O_2 and OH emissions from 94 km and 87 km, and the measurements are divided into 12 sectors with an annular field of view. During these observations, MLT coolings related to SSWs (Sudden Stratospheric Warming) were reported. A consistent correlation of emission rate and temperature from winter to winter was also found. Future SATI applications include an atmospheric wave propagation study involving vertical and horizontal information using the phase differences between the O2 and OH emissions as well as the phase differences between sectors. The method is introduced in this presentation.

4B3.3
SERIES Extended: A 750,000 year record of nitrogen and oxygen dynamics in the Gulf of Alaska
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The Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) showed enhanced primary productivity in response to a geologically instantaneous injection of iron. But are the controls on primary production in the modern ocean representative of the controls on export

production in the Northeast Subarctic Pacific when integrated over decades or centuries? High-resolution analysis of a 44 m-long sediment core collected from the Patton-Murray Seamounts, NW of the SERIES site, reveals pronounced variations in sedimentary trace element concentrations (Mo, U), the concentrations of biogenic components (organic C, opal and carbonate) and the nitrogen isotopic composition of the bulk organic matter. These data indicate that the modern response to iron fertilization is dependent upon the regional oceanographic context, which has itself varied dramatically over the past 750,000 years. Not only have there been wide variations in export production, controlled by surface-ocean processes including nutrient supply from the south, but there have also been significant changes in subsurface oxygenation that were not directly related to the local vertical flux of carbon. At the core site, there is no evidence that enhanced iron supply during glacial periods led to an increase in export production. Comparisons with export productivity and oxygenation records from locations to the west (near Kamchatka) and the southeast (Vancouver Island and California margins) confirm that the observed deep-water variability was of ocean-wide extent in the North Pacific. At the same time, comparisons of the nitrogen isotope record to records from the west suggest that iron fertilization was, in fact, important in controlling the degree of nitrate utilization in the western subarctic gyre. Thus, although the supply of iron to the ocean surface does not appear to control the time-integrated export flux of carbon to the deep subarctic Pacific, enhanced iron availability may have allowed more complete macronutrient utilization, strengthening the local biological pump to some degree. Ironically, the accelerated removal of macronutrients from the shallow ocean may have impoverished the upper ocean nutrient inventory, decreasing export fluxes. As such, the capacity of physical circulation to return nutrients to the surface is highlighted as the primary control.

3DPA3.14
Visualization of seasonal-diurnal climatology at Canadian airports
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A set of graphs has been made which displays the seasonal-diurnal climatology at 191 Canadian airports, based on records of hourly observations made during the period from 1971 to 2004. Summaries of observed variables are graphed as fields along two axes: time of day horizontally and time of year vertically. Field values refer to probabilities of discrete weather events and to statistics of continuous weather variables. Weather described includes: fog, cloud ceiling, thunderstorm, blowing snow, precipitation (any type), snow, ice pellets, freezing rain, freezing drizzle, rain, drizzle, temperature, dew point temperature, dew point temperature depression (spread), wind speed, and station pressure. These graphs reveal interesting patterns in diurnal and seasonal variation of basic weather variables, composite weather variables, and weather hazards.
Supplementary website: http://collaboration.cmc.ec.gc.ca/science/arma/climatology

1DPA1.11
Utilizing Prognostic GEM Rainfall Data to Improve the Skill of the GEM/HAILCAST System
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A new methodology is introduced for the purpose of reducing the false alarm area of hail maps produced using prognostic GEM model soundings and HAILCAST. The proposed technique involves applying a forecast precipitation mask (from the GEM model) to restrict hail forecasts to those areas where convection is forecast during a 6 to 12 hour window centered on 00 UTC. We postulate that this approach is advantageous because it integrates both the thermodynamic and dynamic output from the GEM model. Moreover, integrating the forecast precipitation over time is expected to be superior than using a static CIN or vertical motion mask (only valid for a single time) to delineate between convectively active and quiescent areas.

A comparison was made between the spatial distribution of observed hailfall (as estimated from radar reflectivity measurements) and predicted hailfall using HAILCAST model both with the rainfall mask and without rainfall masks. Inter-comparison of these three products suggest that applying the GEM rainfall mask reduces the False Alarm Ratio (FAR) of hailfall on many cases, while still maintaining a high Probability of Detection (POD). As the predicted precipitation amounts are readily accessible from the GEM model with a long lead time, applying the rainfall masks is easy to implement. Future work will focus on quantifying the improvements of using the precipitation masks based on the 15-km GEM model output.

3B1.2

The Aerosol Optical Network; a pan-Canadian, ground-based network for the monitoring of aerosol properties and the evaluation of spatio-temporal aerosol models

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(Presented by / Présenté par ***Norm O'Neill***)
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The Canadian Aerosol Optical Network (AON) is an informal collaborative relationship between the AEROCAN/AERONET (sunphotometry, starphotometry and sky radiometry) network and aerosol optical lidars located at Egbert Ontario, Halifax, Nova Scotia and, in the near future, at the PEARL observatory located at Eureka, Nunavut. Instruments in the AEROCAN network include CIMEL sunphotometers/sky radiometers from which aerosol content, size and type information can be extracted, starphotometers for night-time aerosol measurement and fish-eye sky-imaging devices for assessing cloud contamination. The aerosol profiling lidars include both mobile and stationary ground-based lidars at Egbert and Halifax as well as an airborne lidar at Egbert. Eureka resources include a HSRL (High Spectral Resolution Lidar) and will soon include an RMR (Rayleigh/Mie/Raman) lidar being developed at Dalhousie University. The capabilities of the AON will be illustrated with recent work involving the monitoring and characterization of trans-Pacific dust, trans-Pacific and trans North American smoke, regional pollution and marine aerosols. The utility of this data in evaluating the performance of regional and global air quality models will also be demonstrated in terms of recent research findings.

1C2.7

Nowcasting High Impact Weather at a HUB Airport Terminal

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A Nowcasting System for HUB airports is being designed for use at major Canadian airports. The system will rely on existing routinely available weather information including numerical weather prediction output, and on-site routine sensors, augmented by additional instruments and high resolution model output as considered necessary for forecasting critical parameters. Existing weather radar information and lightning network information will be integrated into the forecasts. The system will run in a Nowcasting mode, detecting hazardous weather and providing forecasts out to about 3-6 hours for most phenomena, and out to 12 hours for some subset of phenomena. The input of weather forecasters will be focused on quality control in the short time periods with more input as the forecasts go out to 12 hours.

The HUB forecasts would initially focus on the high-impact aviation variables that have the greatest effect on airport capacity/safety on a day-to-day basis, and provide a graphic representation of forecast aerodrome weather and corresponding airport capacity/safety. These variables would include: snow and rain events, freezing precipitation and ice pellets, frost, blowing snow, icing aloft, high winds, wind shifts/shear, lightning, low ceilings, low visibility and fog.

Initial development will focus on Pearson International Airport. This presentation will describe the current plans and provide illustrations of potential products. This will include a discussion of the process whereby graphical forecast products based on end-user input are developed and tested. The presentation will also highlight the progress in the science behind the nowcasting algorithms and suggest gaps in the science that need to be addressed.

4DPA7.6
Spatial and temporal patterns of microzooplankton grazing in contrasting biogeochemical provinces of the Atlantic Ocean
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Microzooplankton grazing plays an important role in mediating the biogeochemical cycling of carbon, nitrogen, sulphur and iron in the upper ocean. Thus, microzooplankton directly and indirectly influence the net air-sea flux of CO_2 and other climatically active gases. As part of the Canadian Surface Ocean Lower Atmosphere Study and the Atlantic Meridional Transect program we quantified microzooplankton bacterivory and herbivory in diverse biogeochemical provinces in Atlantic Ocean, including regions impacted by Saharan dust deposition, the North and South Atlantic gyres, and higher latitude, temperate, subarctic and arctic biomes. Microzooplankton bacterivory and herbivory varied seasonally and spatially, and ranged from not significantly different from zero, to more than four per day, with the highest rates observed in during the summer. High rates of bacterivory (1.0 d^{-1}) were observed in slope waters along the Northwest Atlantic continental shelf, and high rates of herbivory (4.1 d^{-1}) were observed in Arctic waters, within the Greenland current. Rates of microzooplankton grazing were highly correlated with prey growth rates, particularly in the sub-tropics, with higher rates of growth than grazing loss at higher latitudes. These patterns have important implications for our understanding of carbon cycling, remineralization and export in major ocean biomes and for ocean-climate models.

3DPA3.3
Subjective evaluation of the new canadian high-resolution medium-range weather forecast
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The Analysis and Prognosis Division (A&P) is doing a subjective evaluation of the new Canadian high-resolution medium-range weather model that is currently running in parallel mode. We will present cases that demonstrate strength and weakness of this new model.

4C2.8
Circulation in the Placentia Bay: A modelling study
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A high-resolution three-dimensional finite element model is used to simulate circulation in the Placentia Bay and its vicinity off South Newfoundland. The model forcing consists of wind stresses, density gradient, and sea level specified on the open boundary from a larger-scale shelf model. Major tidal constituents are also included in the calculation. The model results are compared with tide-gauge data and moored current meter observations. The model circulation fields are used to study dispersion patterns for potential environmental and biological implications in this region.

4DPA8.10
Tidal modeling in the Northwest Atlantic
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The tidal response off Northwest Atlantic Ocean is studied through simulations with a three-dimensional, prognostic, primitive equation model. The model domain extends from 75 ^{o}W to 42 ^{o}W and from 36 ^{o}N to 66 ^{o}N. The model is forced at the open boundaries with the leading semidiurnal (M2, N2 and S2) and diurnal (K1 and O1) constituents. The open boundary conditions for the 5 constituents are obtained from a North Atlantic tide model.

Experiments with two different resolutions (1/3 and 1/12 deg) and with homogeneous and stratified fluid are carried out and compared. Harmonic analysis is used to analyse the elevation data generated from the model runs. The amplitude and phase differences between the present barotropic model solutions and the North Atlantic model are negligible in the deep ocean and notable in coastal areas and semi-enclosed seas. The barotropic response shows good agreement with previously published studies of tides in this region.

An internal tide may be generated in cases where the model is initialized with stratification. Diagnostic experiments (fixed temperature and salinity) are conducted to determine the sensitivity of model tidal currents to stratification in the absence of the internal tide.

1DPA2.15
Ice water content and precipitation rate as a function of equivalent radar reflectivity and temperature based on in-situ observations
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Satellite observations and general circulation model (GCM) studies show that ice clouds have an important impact on earth's climate by influencing the radiation balance and hydrological cycle]. However, the value of ice water content (IWC) and precipitation simulated using the state of the art numerical models vary significantly. Occasional aircraft in-situ observations provide very valuable information about the microphysical properties of clouds, but this data cannot validate climate models on a global scale. Radar technology is increasing being used for remotely retrieving cloud microphysical parameters. Since radar can be operated continuously, it can provide long term measurements of cloud properties. An experimental satellite, CloudSat, that is planned to be launched in 2006, will carry a 94 GHz radar. This radar should provide a global picture of cloud microphysical properties including IWC that can be used to constrain these models. However, radar measures the equivalent reflectivity factor ( ) of the cloud particles, but not their mass. The accuracy of the retrieved ice mass or ice precipitation rates based on radar reflectivity is highly dependent on the algorithms used. These algorithms are usually developed based on in-situ aircraft or ground measurements, or in combination with radar and in-situ measurements. In most cases, these retrieval algorithms normally include just one variable, .

In this paper, we will discuss the development of two algorithms for retrieving ice water content (IWC) and ice precipitation rate ( ) as a function of temperature and Z using ice particle spectra measured in stratiform ice clouds in midlatitude and Arctic regions. These parameterizations will be compared with a) direct measurements of IWC using a Nevzorov probe, b) precipitation retrieved using an X-band Doppler scanning radar and a Precipitation Occurrence Sensor System (POSS), c) the Canadian Global Environmental Multiscale (GEM) and High Resolution Model Application Project (HIMAP) models, and d) derived IWC and precipitation from measured ice spectra during four field projects.

3C3.5
Newfoundland Operational Ocean Forecasting System (NOOFS): model implementation and validation
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A requirement for more reliable prediction of the ocean's structure and circulation drives the need to understand its physical processes. The numerical model NEMO/OPA is used to do ocean studies in order to reach that objective. Our region of interest is the Northwest North Atlantic with a focus on the Canadian East Coast Shelves and the Gulf of St. Lawrence. This development of ocean forecasting capability, is done as part of larger national ocean forecasting effort in conjunction with other DFO laboratories (BIO, IML) and environment Canada. The first prototype will have a resolution of 1/4th of a degree for the whole domain of study and 1/12th for the shelf/gulf domain. The high-resolution part is obtained by the application of the AGRIF package on the numerical model. For validation purposes, the model was forced with different types wind fields (including climatological fields, wind from the Environment Canada, EC, global and regional models, as well as EC wind fields blended and corrected using RadarSat-derived wind measurements) with different types of boundary conditions.

We describe the setup of the oceanographic pre-operational system for the Newfoundland region together with preliminary results. The comparison of the different model outputs with in-situ measurements, from various transects carried out regularly across the shelf of Newfoundland and Labrador is also presented.

The implications of this research and development project are demonstrated using a scientific version of the Canadian Coast Guards CANSARP (Canadian Search and Rescue Software) for determining the input of new environmental forecast data to Canadian search and rescue capacity.

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The implications of this research and development project are demonstrated using a scientific version of the Canadian Coast Guards CANSARP (Canadian Search and Rescue Software) for determining the input of new environmental forecast data to Canadian search and rescue capacity.

4DPA8.11
On the vertical alignment of oceanic and atmospheric streams
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We are quite familiarized with the tilted structure of oceanic and atmospheric baroclinic jets when plotted as a function of depth or pressure, but there is no evident reason for such tilting. In this work we study the vertical alignment of both oceanic and atmospheric streams using in-situ measurements as well as numerical model outputs. It is shown that the baroclinic jet may be aligned either with depth or with density but not simultaneously with both. The observations indicate that streams are vertically aligned only when observed in isopycnic coordinates (isentropic coordinates for the atmosphere), but only in a natural system, a system normal to the current axis. The alignment is also clear in the geostrophic velocity fields inferred from hydrographic data, in either the coastal or the deep ocean. We propose that the density alignment is the result of the inertial character of intense oceanic and atmospheric streams.

2B3.7
Carbon Cycle Science by Fourier Transform Spectroscopy (CC-FTS) Mission
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Since the start of the industrial revolution, the atmospheric concentrations of CO_2, CH_4, and N_2O have increased by about 33%, 150% and 17%, respectively. These changes in the greenhouse gas concentrations are considered as major factors affecting the climate. The prediction of climate change is dependent on our understanding of the carbon cycle. What is needed ideally to improve our understanding of carbon cycle is a detailed four-dimensional global map (latitude, longitude, elevation and time) of greenhouse gases. By application of the inverse modeling method, regional sources and sinks can be identified. Such a global data set can only be acquired from orbit, so we are developing a satellite mission using a Fourier transform spectrometer operating in the near infrared region 4000 – 14000 cm^{-1} to monitor the total columns of greenhouse gases CO_2, CH_4 and N_2O plus the CO precursor for carbon cycle studies. The algorithms for the column density retrievals benefit from the heritage of the Atmospheric Chemistry Experiment (ACE) mission. The goal of measurement to achieve 0.3% precision (about 1 ppm out of 370 ppm averaged over the column) under the most favourable circumstances for CO_2. For CH_4, CO and N_2O the requirements are less demanding mainly because the level of existing knowledge is poorer than for CO_2. This precision implies the use of a reference band, likely the O_2 A-band, to determine the effective optical path and for cloud detection. Detailed instrument requirements and mission description will be presented.

1DPA2.4
A simple approach toward cloudy infrared radiance assimilation with application to the AIRS instrument
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A variational estimation procedure for the retrieval of effective cloud top height and emissivity is proposed. The method is based on a cloud emissivity model which accounts for the frequency dependence of cloud absorption and scattering, and possible mixed phased situations. The method is applied to real AIRS observations, using 61 channels mostly sensitive to temperature. A 6-h forecast serves as background field, and remains fixed. Monte Carlo experiments indicate that the best retrievals are obtained for cloud tops in the range 200-700 hPa and emissivity in the

range 0.5-1. Difficult situations are most often associated with near isothermal layers or boundary layer clouds. The problem of infrared cloudy radiance assimilation is approached by assuming that the atmospheric and cloud contributions to observed radiances can be well modelled if the effective cloud parameters are known precisely. Under these conditions, the assimilation of cloudy infrared radiances to get information on temperature and water vapour above and possibly below the cloud appears feasible over a broad range of situations defined by the two cloud parameters. Examples of 1D-var assimilation are shown, using 100 AIRS channels, this time including humidity channels and allowing the atmospheric state to vary. The impact of cloudy radiance assimilation is expected to be maximum in situations of broken to overcast mid-level clouds. Results of 3D-var experiments using this approch should be available at the time of the conference.

3DPA5.2
Validation of ocean forecasting output using in-situ information from seal based observations
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As part of the Canadian effort in regional ocean forecasting, the Newfoundland Operational Ocean Forecasting is setting up an ocean forecasting system that is nested within the MERCATOR North Atlantic Ocean forecasting system. This talk focuses on the validation of both the MERCATOR forecast system for the North West Atlantic Domain for the NOOFS ocean forecasting system using seal based and ARGO in-situ observations. The values and concerns of seal based observations will also be presented and discussed. In-situ temperature and salinity profiles were taken for 2004 and 2005 with further field seasons in 2006 and 2007.

3DPA3.19
Weather's Effect on the St Lawrence River System.
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The St. Lawrence River is Canada's most commercial waterway. In January 2006, the Canadian Hydrographic Service (Quebec Region) of the Department of Fisheries and Oceans Canada contracted Axys Technologies Inc. to upgrade the water level gauge stations along the 300 Km stretch of river between Cap-aux-Meules (Magdalen Islands) and Montreal. This network named SINECO provides the real-time environmental data necessary to manage this essential transportation link. The data collected by this network is critical to Canada for:

- Marine traffic control
- Underkeel clearance
- Optimization of ship's cargo volume
- Regulation of the water system
- Hydrographic surveys
- Validation of tide predictions & analysis of mean sea level
- Chart Datum management
- Water level forecasts
- Hydrodynamic models - currents, storm surge, etc.
- Shore erosion studies.

In this presentation, we will discuss the effects of weather on the St. Lawrence River System, their effects on transportation/commerce and the role played by the water level network.

4DPA6.10

Air quality model simulations of a smog episode using newly developed database and system to estimate biogenic and mobile emissions at high resolution

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Ozone, a main smog component, is produced by nitrogen oxides (NOx) and volatile organic compounds (VOC) under sunny and hot weather conditions. In order to improve the estimation of the emissions of these two families of chemical species in space and in time, two separate projects were conducted, one aimed at improving the biogenic emission of VOC and a second one to improve the most important source of NOx in urban environment which is on-road vehicles.

The available land cover database needed to estimate biogenic emissions of VOC is derived from satellite imagery at a 1-km resolution. It has been recently improved over Eastern Canada by incorporating high resolution data from the Canadian agricultural census and the Canadian Forest Inventory. Also, the on-road emissions were computed with a bottom-up approach consisting of a simulation of the traffic flow of the Montreal metropolitan area coupled with the MOBILE6C model which computes the emissions based on the number and type of vehicles and their speed.

Simulations of a summer smog episode in the Windsor-Quebec City corridor with the Canadian models GEM and AURAMS will be compared with the available measurements. The sensitivity of the models to the emissions of NOx and VOC will also be evaluated.

3DPA3.20
Filtering of wind-borne particles by a natural windbreak

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New measurements of the transport and deposition of particulates (glass beads) around a thick "shelterbelt" of maize (width/height ratio W/H = 1.6) are compared against simulations with a Lagrangian stochastic trajectory model driven by a computed wind field from a RANS (Reynolds Averaged Navier Stokes equations) model. We illustrate the ambiguity inherent in applying to such a thick windbreak the pre-existing thin windbreak theory of particle filtering by vegetation, and show that the present description, while much more laborious, provides a satisfactory account of what was measured. A sizeable fraction of the particle flux entering the shelterbelt across its upstream face is lifted out of its volume by the mean updraft induced by deceleration of the flow in the near-upstream and entry region: these particles thereby escape deposition.

3C3.7
Simulation and energetics of eddies in the Northeast Pacific

Jennifer Shore [1] , Michael Stacey [1] , Dan Wright [2]
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The Parallel Ocean Program (POP) has been used to simulate the circulation of the North Pacific Ocean. Our specific area of interest is the Northeast Pacific, focusing on the eddy activity of the currents along the coasts of British Columbia and Alaska. The model has 0.25 degree horizontal resolution and 23 vertical levels that increase in thickness from the surface to the bottom. The temperature (T) and salinity (S) fields of the model are initialized with observational estimates and surface heat and momentum fluxes are determined by monthly climatological estimates from COADS. The long term mean T and S fields produced by the model are nudged towards the corresponding observed fields using `spectral nudging' which allows the eddy field in the model to

evolve while holding the model's mean T and S fields close to the observed climatology. The modeled circulation is spun up from rest and is run for a simulation time of 20 years. Eddy trains develop in the model that are similar to those observed through satellite imagery. The model is used to estimate the size, propagation rate, and stability characteristics of the eddies. Both the depth-integrated barotropic and baroclinic energy transfers are significant but, contrary to expectations, the barotropic transfers are the somewhat more important source of energy for eddy growth. This is particularly clear along the coast of BC north of the Queen Charlotte Islands. Both energy transfer rates tend to be higher along the Alaskan coast than along the BC coast. Along the Alaskan coast the barotropic transfers primarily extract kinetic energy from the mean currents, while there are both positive and negative bands of baroclinic energy transfer. On average, eddies are flattening isopycnals (extracting potential energy from the mean density field) offshore of the main current but feeding potential energy into the mean state near the shelf break.

1DPA1.17

Towards the implementation of a new radiative transfer parameterization in GEM

Paul Vaillancourt [1], Donald Talbot [4], Jiangnan Li [3], Bernard Dugas [2], Katja Winger [2], Martin Charon [2]

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A major overhaul of the radiative transfer parameterization, used in the operational NWP models (GEM), is under way at MSC. The objective is to replace the operational broad band RT scheme with a correlated k-distribution (CKD) method proposed by Li and Barker (2005).

Li and Barker have proposed a new CKD model for gaseous transmission that uses much less intervals in the cumulative probability space than other CKD models. Up to 1 mb only 20 (solar) + 22 (infrared) main intervals are needed. This scheme uses 9 frequency intervals for LW and 4 for SW. This scheme is being used at the Canadian Centre for Climate Modelling and Analysis (CCCma) in the GCM version 4 model.

The scheme has been tested both in forecast mode and in climate mode. It has been tested within the current operational GEM models and also within two versions in development; GEM-Meso and GEM-Strato. Results from these tests have shown a much improved temperature structure of the stratosphere as well as the position of the tropopause and the jet streams. A comparison with the global radiosonde network has shown some systematic improvements in temperature and winds for short and medium range forecasts. Comparison with surface radiative fluxes measured at ARM and SURFRAD sites have shown reduced biases in the model fluxes.

At the CMOS meeting, the impact of this new parameterization on short, medium and climate time scale simulations will be presented.

4DPA7.14
The impact of a moving storm on the chlorophyll distribution in the Labrador Sea

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The immediate response, through vertical redistribution of the chlorophyll field, to a steadily moving storm is investigated using a 3-D ocean circulation model of the Labrador Sea. The model is forced by a prescribed wind and pressure field. The numerical experiments include a control run to analyze the horizontal and vertical structure of the chlorophyll field, and several sensitivity runs to investigate the response to changes in the storm parameters (translation speed, size and intensity) and the seasonal distribution of chlorophyll. The model results show that after the passage of the storm, surface chlorophyll in the Labrador Sea is generally increased by vertical mixing. The largest increase occurs in autumn. In summer (control run), the surface chlorophyll concentration is one to three mg m^{-3} higher than the concentration before the storm in almost all the areas under the influence of the storm. In the shelf regions, however, the increase is very small. The changes in surface chlorophyll concentration are shown to be primarily controlled by the mixed-layer depth and the initial chlorophyll distribution. Nitrate brought from the deep reservoir to the mixed layer by entrainment is estimated from the model. For a typical storm in summer, 33.5×10^3 mol of new nitrate is added to the mixed layer for each kilometre of storm track. Primary production consequent on the introduction of new nitrate will contribute to further change in surface chlorophyll, but on a longer time scale.

1DPA1.21
The TOA Advanced Lightning Positioning System (ALPS): a next-generation time-of-arrival based lightning location network; system characteristics and performance in the USA and Asia

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The TOA *ALPS*™ technology was introduced to the world market in 2003 after having been proven in operation in Australia. *ALPS*™ provides real-time CG-Stroke and CLD-Flash locations with very high accuracy and detection efficiency. The system also has proven long-range detection capabilities at ranges in excess of 2000 km.

The presentation will discuss sensor performance characteristics, siting and communications considerations, and provide examples of severe thunderstorm activity in N. America and Asia -- with special emphasis on intense lightning activity observed during recent tropical storms, and long-range detections over the Andes, by the US Precision Lightning Network (USPLN), which is operated jointly by TOA Systems, Inc. (TOA) and Weather Decision Technologies Inc. (WDT).

4DPA8.6
Modeling the Regional Climate Impact of Boreal Lakes

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It has long been known that the land surface plays a crucial role in the global climate system. Processes governed by complex topography or heterogeneities in surface vegetation and soil properties are frequently analyzed using high resolution regional climate models coupled with elaborate soil-vegetation-atmosphere transfer (SVAT) schemes. Such schemes model the moisture and energy balance of soil, vegetation and snow, generally incorporating a sophisticated treatment of radiative and turbulent exchange with the overlying atmosphere. One surface type that is normally disregarded in climate models is lake, even though it is well known that fluxes of heat, moisture, and momentum can be significantly different in the presence of open water. This is due to the large difference in heat capacity, roughness length, and albedo of water compared

with nearby soil and vegetation, as well as differences in the vertical transfer of heat in the water column compared with that on land.

In this study, the impact of boreal lakes on the regional climate is evaluated though a series of regional climate model experiments over central Canada. High resolution (~ 25 square km) is achieved through a cascading sequence of simulations in order that the boreal lakes are resolved on the model grid. Lake surface temperatures and ice cover are specified in this initial series of experiments based on the NOAA/University of Miami's 4 km resolution AVHRR Pathfinder project, and the gross impact of the lakes on the local boreal climate is estimated by comparison with control simulations where the lakes have been replaced by soil and vegetation consistent with the nearby land surface. Because most boreal lakes are sub-grid scale in current generation climate and numerical weather prediction models, the development of a 1-dimensional lake parameterization module for the SVAT used in Canadian models, known as the Canadian Land Surface Scheme (CLASS), will also be discussed.

1B3.5
Equatorial Deep Jets Triggered by Western Boundary Current Variability
Marc d'Orgeville [1], *Lien Hua* [2]
(Presented by / Présenté par ***Marc d'Orgeville***)
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The response of the equatorial track to an oscillatory baroclinic western boundary current is investigated in a continuously stratified primitive equation model. The symmetry of the current about the equator is such that Mixed Rossby Gravity Waves (MRGWs) are excited in the western part of the equatorial track. Depending on the forcing frequency, short to long scales monochromatic MRGWs can be selected. In the short scale regime, the subsequent MRGW destabilization leads to a higher vertical mode response than the forced MRGW's mode. The selected vertical mode of the response is a function only of the forcing frequency, as demonstrated in a channel geometry by Hua et al. (OS 2006).

In a basin geometry, the destabilization occurs in the vicinity of the western boundary layer and leads to the formation of finite amplitude zonal jets of high vertical modes in the whole equatorial track. Their spatial and dynamical characteristics are compatible with those of the observed Equatorial Deep Jets. The time-variability of the achieved circulation correspond to low-frequency oscillating equatorial basin-modes whose period is set by the dominant vertical mode of the response. As a result, an oscillatory western boundary current leads to a permanent equatorial zonal circulation on the contrary of a steady western boundary current.

2C2.8
A Winnipeg F4 Tornado - A Virtual Damage Assessment
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On May 3, 1999, a major tornado outbreak struck Tornado Alley in the United States. One of those tornadoes, an F5 on the Fujita scale, struck metropolitan Oklahoma City, OK, causing over $1 billion (USD) in damage, injuring hundreds and leaving 38 people dead. The impacts of this tornado were extensively documented. The North Central Texas Council of Governments saw an opportunity to use this information to make a risk assessment of a similar tornado striking Dallas, TX. Using the Oklahoma City tornado path and its various intensities, numerous fictional tracks were laid across the Dallas-Forth Worth Metroplex. The tracks were combined digitally with other databases including property assessments, demographics, land use classifications, etc., to predict the impact on the city. The final assessments calculated the total property damage and

estimated the number of people affected. This information was used by the city to be better prepared to face a major tornado disaster.

A similar assessment can be made for Canadian communities. Canada's cities are not immune from major tornadoes. The cities of Regina (1912), Barrie (1985), Windsor (1974) and Edmonton (1987) have all had devastating tornado disasters. Like Oklahoma City, the Edmonton tornado was extensively surveyed. This paper examines the impact of a fictitious Edmonton-like tornado on the City of Winnipeg using a non-GIS approach. Included in this virtual scenario is the major hailstorm that accompanied the Edmonton tornado. Using similar historic events, an attempt was made to approximate damage costs, injuries and deaths. The results point to the possibility of a major catastrophe well beyond the most notorious of Canadian tornado disasters. Scenario research like this can help emergency planners plan for similar events. Research on recent real-life disasters has highlighted opportunities to mitigate the effects of these events. Some of those lessons will also be discussed.

3DPA3.9
RANS simulations of disturbed 3-D winds in a square plot enclosed by porous fence
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When the wind is incident on a "sheltered" plot across the corner of the "protecting" windbreak, mean winds in the plot exceed those in the open within a jet that extends across the plot along its diagonal. This effect is important in the context of shelter for horticulture, and has been hypothesized to result from the action of a pair of counter-rotating streamwise vortices, induced by the sharp corner. Accordingly one may doubt that RANS (Reynolds-averaged Navier-Stokes) computation of such winds could be at all realistic. However in this talk we will show that to the contrary, simulations of the unstratified case performed with FLUENT's "realizable k-epsilon closure" on a fine grid are in at least qualitative accord with the observed mean winds, albeit sparsely sampled, in such a plot.

2B3.1 **INVITED / INVITÉ**
Environmental Control of Net Ecosystem Carbon Dioxide Exchange in Contrasting Peatlands in northern Alberta, Canada
Larry Flanagan
(Presented by / Présenté par ***Larry Flanagan***)
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Peatlands cover about 21 per cent of the landscape and contain about 80 per cent of the soil carbon stock in western Canada. However, the current rates of carbon accumulation and the environmental controls on ecosystem photosynthesis and respiration in peatland ecosystems are poorly understood. As part of Fluxnet-Canada, we continuously measured net ecosystem carbon dioxide exchange (NEE) using the eddy covariance technique in a treed fen (main site) dominated by stunted black spruce and larch trees during 2003-2005. Additional NEE measurements were made at two auxiliary sites during intervals in the active growing season (May through September) in both 2004 and 2005. One auxiliary site was dominated by Sphagnum moss, while the dominant species at other site were Carex and brown mosses. The NEE measurements were used to assess temporal variation in physiological parameters for ecosystem photosynthesis and respiration. In addition, ecosystem carbon dioxide fluxes were compared to carbon stock measurements and rates of carbon accumulation in peat cores. In this talk I will describe the ecological differences among the three contrasting peatland types, illustrate the variation among ecosystems in their current and past rates of net carbon sequestration, and

discuss the insights provided by our measurements for how these ecosystems will likely respond to altered environmental conditions associated with climate change.

1B2.2

The Hydromet Decision Support System

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Weather Decision Technologies, Inc. (WDT), founded in 1999, is a global leader in providing state-of-the-science weather detection, nowcasting, and forecasting systems and services to our partners and customers. WDT is headquartered in Norman, Oklahoma and maintains an international marketing office in Arlington, Virginia.

The founders and employees of WDT are all veterans of world-leading weather research and development organizations; people with unmatched experience in applying the latest technologies to the critical problem of accurately detecting, nowcasting and forecasting significant weather events. WDT personnel have managed the development, integration, and setup of advanced meteorological hardware/software systems and services for many clients both in the United States and internationally.

The Hydromet Decision Support System (HDSS) is a system that was developed to support decision makers who need to operationally:

- predict flash floods and warn the public
- manage dams, canals, streams, rivers and rain run-off systems on a routine basis and during extreme events
- manage hydro-electric facilities
- forecast river flooding.

The HDSS integrates all available meteorological and hydrological data, including radar, satellite, model, surface, and rain gauge data using a real-time system that includes a suite of state-of the science algorithms. HDSS consists of the following algorithms and functions:

- Data quality control and building a 3D mosaic of the data
- Quantitative Precipitation Estimation using the QPE-SUMS algorithm from NSSL.
- Quantitative Precipitation Forecasting (QPF) using the McGill Algorithm for Precipitation Nowcasting Using Semi-Lagrangian Extrapolation (MAPLE)
- Flash Flood Prediction Algorithm

WDT customizes and tunes the HDSS to meet our customer's operational needs. A custom display is provided that shows all of the data in a 3D framework or in a Web based display.

4C4.4

Analysis of recent changes and potential future developments of the wind, wave and storm surge climate: The North Sea area.

Ralf Weisse [1], *Hans von Storch* [1], *Andreas Pluess* [2], *Katja Woth* [1], *Frauke Feser* [1], *Heinz Guenther* [1], *Iris Grabemann* [1]

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A comprehensive analysis of the regional wind, wave and storm surge climate for the North Sea area is presented. The analysis is based on a consistent series of high-resolution multi-decadal hindcasts and climate change scenarios for the atmosphere, ocean waves (sea state) and storm surges. In addition, observed and reconstructed storm indices are considered. It is first shown that the met-ocean hindcasts reasonably describe the observed conditions, in particular the statistics of extreme events. It is further demonstrated that the storm activity as well as related changes in ocean wave and storm surge statistics have undergone considerable variations in the recent past but exhibit no clear trend. From the climate change scenario runs climate change signals for wind, waves and storm surges are determined and assessed against the long-term variability estimated from the hindcasts. In addition, uncertainties caused by the application of different models as well as different climate change scenarios are quantified. For storm surges, rather similar climate change patterns that exceed the variability estimated from the hindcasts were identified among all models and scenarios. For the sea state, the uncertainties caused by the application of different models are of the same order of magnitude as the signals themselves. Although the method has been applied here to assess regional climate change projections for the North Sea it may be applied in a similar way to other regions as well. An outlook for an application in the Baltic Sea will be given.

4C4.2

Downscaling and projection of the winter extreme daily precipitation over North America

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Downscaling and projection of the winter extreme daily precipitation
over North America

Jiafeng Wang and Xuebin Zhang

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The relationship between observed winter (December-March) maximal daily precipitation over North America and reanalysed atmospheric elements is built by statistical downscaling. The extreme precipitation is modeled as generalized extreme value (GEV) distribution, and the atmospheric predictor variables are included as covariates, which are large-scale circulation index represented by the associated principal components of leading EOFs (empirical orthogonal functions) for sea-level pressure, and air moisture described by gridded specific humidity at 850hpa level. Maximum likelihood method is used to estimate the regression coefficients and *r*-largest method is employed to improve the estimation precision.

The feasibility of this method is tested through calibration-validation procedure and the derived relationship is further used to project the change in extreme precipitation in the background of climate change. Predictors are extracted from climate model simulation conducted with CGCM3.1(T47) in Canadian Centre for Climate Modelling and Analysis. Result shows that the risk of heavy precipitation increases over almost the whole continent, except Canadian Prairie.

3DPA3.5

A Verification of Post-Processing Routines for Surface Based Wind Gusts and Cloud-Top Heights

Nathan Maslanko
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From 2001 to 2005, several post-processing routines, developed by the Canadian Meteorological Aviation Centre (CMAC), were developed based on CMC's (Canadian Meteorological Centre) GEM Regional Model. A number of these routines have expanded into various products adapted specifically to aviation forecast operations.

One of these routines, which has been integrated into CMAC's 'TAFtime' product, focuses on surface gusts. Initial results suggest that gust values are generally overestimated but data throughout the convective season needs to be analyzed before any conclusions can be made.

A second routine, integrated into CMAC's 'Thermobot' product, focuses on a convective analysis including cloud-top heights. An automated verification scheme was developed examining 'Thermobot's' output versus actual radar echo-top values. Preliminary results will be known early in the convective season.

3DPA2.12
Transposition des algorithmes radar aux sorties du modèle GEM-LAM à haute résolution pour fins de prédiction de temps violent estival. / GEM-LAM high resolution model comparison with radar algorithms for severe summer weather
Pierre Vaillancourt , Denis Jacob
(Presented by / Présenté par ***Stéphane Gagnon***)
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Les modèles de prévisions météorologiques sont à une échelle de plus en plus fine ce qui les rapprochent constamment de la résolution de l'instrumentation de télédétection à large couverture comme les radars. De plus, les modèles à haute résolution comme le GEM-LAM (2,5 km) peuvent utiliser des équations inélastiques et non hydrostatiques explicites pour mieux simuler la réalité au lieu de schèmes paramétriques. Il serait donc intéressant d'utiliser les sorties de différents champs de ce modèle et de les comparer à ce que l'on peut voir dans le même cas avec un radar météorologique. Est-ce que les deux sont comparables seulement à un niveau grossier ou peut-on reproduire avec assez de finesses le comportement des nuages pour appliquer les algorithmes de détection des orages violents aux données du modèle?

Meteorological numerical models are now produced at a finer scale, get closer to the scale of remote sensing devices like radars. Furthermore, these models, like the GEM-LAM (2.5 km) are using explicit parameterization of convection including non-hydrostatic equations instead of implicit schemes. It would then be interesting to compare model outputs with radar of the same events to see what similarities and differences could be noticed. Could we then use radar algorithms to detect severe thunderstorm characteristics in the model output?

1DPA2.1
Assimilation of AIRS radiances at the CMC
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CMC receives in real time a subset of 281 AIRS (Atmospheric Infrared Radiance Sounder) channels covering the spectral range 3.7-15.4 micrometers. A sub-ensemble of 100 channels has been selected for assimilation in operational global analyses based on their information

content on temperature and humidity. Processing steps such as cloud analysis, bias correction, quality control and horizontal thinning are briefly described.

Impact results on forecasts in terms of 250-850 hPa geopotential anomaly indicate a substantial gain in predictability of 6-h at day 4 in the Southern Hemisphere. The gain is more modest, but consistently positive as well, in the Northern Hemisphere. Operational implementation is therefore foreseen by the end of 2006.

4DPA7.12
The coupling of NODEM-NARCM:interactive simulation of dms
Atif Taoussi
étudiant
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Oceanic dimethylsulfide (DMS) is the major natural source of sulfur to the atmosphere and contributes both to the tropospheric sulfur burden and to particle formation and growth in the atmosphere. The atmospheric sulphate aerosol particles that evolve from biogenically-derived DMS emissions play a role in the global radiation balance directly through the upward scatter of solar radiation and indirectly as cloud condensation nuclei (CCN). It is therefore important to improve our understanding of the processes that regulate air-sea surface DMS concentrations for inclusion into climate models. In order to achieve this goal, NARCM (3D atmospheric model) is coupled with NODEM-GOTM (the coupled physical-biogeochemical ocean model). This step represents a significant improvement over the previous uncoupled version of NODEM that was driven by a diagnostic vertical mixing scheme) and the single column version. The goals of this project are to: 1) provide a coupling 3D atmospheric model (NARCM) with the physical-biogeochemical ocean model (NODEM-GOTM) for climate studies 2) investigate the sensitivity of the coupled model to perturbations of sensitive variables and 3) quantify of the effect of DMS in the atmosphere.

3DPA3.8
One-way Nesting Mixed Phase Clouds Explicit Simulations During the APEX-E3 Experiment
Cristina Stefanof [1], *Jean Pierre Blanchet* [1], *Wanda Szyrmer* [2]
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An explicit mixed phase cloud microphysical scheme, developed previously at University of Quebec at Montreal, was implemented into the Canadian Regional Climate Model (CRCM). It assumes bulk microphysics as a double-moments scheme with three modal categories: cloud liquid droplets, pristine ice crystals (<100μm) and larger precipitation crystals. It is applied, in forecast mode during measurement campaigns, for the simulation of mixed phase clouds. Initially, we focus on the cloud microphysics and the CCN concentrations were prescribed. One-way nesting simulations were performed (45, 9, 1.8 and 0.36 km) during the APEX-E3 Experiment (March to April 2003). In the two first nesting simulations (45 km and 9 km resolution) CRCM is used. The last two high resolutions (1.8 km and 0.360 km) were obtained running the CRCM with explicit mixed phase cloud microphysical scheme. ECMWF data (0.4° resolution) was used to drive the model at 45 km resolution. Detailed cold clouds (and mixed phase clouds) high resolution simulations were generated and verified against in situ measurements. The APEX-E3 campaign, near Japan, used three aircrafts (G-II, C404, B200), two of which measured in-cloud microphysics and one overpass with radar-lidar profiles in preparation to CloudSat-CALIPSIO and EarthCARE satellite missions. Result shows an encouraging agreement between the model simulation and observations. Research is continuing to improve CRCM-CRM scale transition, coupling aerosols-clouds and application into different conditions (Arctic and tropical cirrus).

3B1.6

Canadian Precipitation Analysis Project - Validation and Results

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The Canadian Precipitation Analysis (CaPA) project is an initiative from the National High Impact Weather Laboratory in Montreal and RPN. The CaPA project aims at producing a real-time precipitation analysis every 6 hours with a horizontal resolution of about 15km. The analysis scheme is based on a univariate Optimal Interpolation using 6h accumulation from the regional model GEM as a background field. The surface rain gauge measurements from the national and cooperative network in Quebec are used as observations.

As a first step, a pilot study has been conducted over the Quebec region during the period of August 2003. This test period has allowed the development of methodologies for an objective estimation of background and observation error statistics.

Since the late spring of 2005, real-time 6h accumulations of precipitation analyses have been produced over North America in experimental mode. The resulting analyses have been verified with SHEFF network over USA and with radar data over Quebec for the Summer 2005. The verification with SHEFF network indicates an improvement of quality of the analyses versus the background fields. Over Quebec using radar as verification data, results show significant increase of the quality of the analyses with the use of additional rain gauges from the surface cooperative network.

3DPA5.1

The sweet potato in Polynesia: insights from a computer-driven drift simulation

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The Sweet Potato is a plant native to the Americas but was found to be present in Polynesia in pre-historic times; explaining its presence is a long-standing anthropological problem. A computer-driven drift simulation is used to model the trajectories of primitive seagoing vessels departing from coast of Central and South America and drifting under the influence of local ocean currents and winds. The model is fed with data from an ocean current model with high spatial and temporal resolution. The possibility that the plant was transferred as a result of such an accidental drift voyage, ending up in Polynesia is investigated. The model is also used to investigate the possibility that plant transfer occurred as a result of drifting seed capsules. The most likely landing sites in Polynesia are discussed based on point of origin along the American coast.

1B1.2

The SWIFT Experiment on the Canadian Space Agency's Chinook Mission

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SWIFT (the Stratospheric Wind Interferometer For Transport studies) is a Canadian satellite instrument designed to make continuous global stratospheric wind measurements between 15 and 55 km and provide simultaneous co-located ozone density profiles.

SWIFT is the primary instrument on the Canadian Space Agency's 'Chinook Mission' scheduled for launch in late 2010.

This paper will describe the overall scientific objectives of SWIFT, the measurement technique and the expected impact of SWIFT's observations on atmospheric science.

4DPA6.6
Lidar study of ozone, aerosol and clouds properties at York University, Toronto, Canada
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This poster presents preliminary results of boundary layer (BL) ozone mixing ratio, as well as aerosol and clouds optical properties obtained using two Lidar (laser radars) systems recently developed at York University, Toronto, Canada. The ozone lidar was developed for air quality studies, while the aerosol and cloud Lidar (Phoenix Lidar) was developed in the frame of the Phoenix/Mars project as a field version of the Lidar currently being built for the Martian Artic exploration that will be launched in August 2007. Retrieval of aerosol and cloud optical properties (backscatter coefficients, color ratio), as well as BL ozone concentration have been performed with both lidar systems since September 2005 in Toronto. Recently (January/February 2006), the phoenix lidar was used on an aircraft in Darwin (Australia) to study convective cloud systems in the frame of TWP ICE (Tropical Warm Pool International Cloud Experiment). Some of the results obtained both in Toronto and Darwin will be presented here, together with case studies of cloud/aerosol scene discrimination using the Phoenix lidar system. The significance of the results for climate change and air quality forecasting is also discussed.

3C1.6
Development of the Canadian Aircraft Meteorological Data Relay (AMDAR) Program and Plans for the Future
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The Canadian AMDAR Program is consistent with the system of systems approach to monitoring, i.e. with the need for an appropriate mix of in-situ,remote, air borne, and space-based monitoring systems. The development of AMDAR by the Canadian AMDAR Program Implementation Team (CAPIT) has not been typical as Canada started developing its program from regional air carriers, meaning no simple solutions existed as these carriers usually operate older aircraft using less sophisticated sensors, avionics and datalink systems when such systems are available.

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Canada now has an operational AMDAR Program with a growing fleet to 64 DHC-8 and over 40 CRJ aircraft from Air Canada Jazz expected to report valid temperature and wind data across Canada (mostly south of 55N) by fall 2006. AMDAR data from Air Canada Jazz began distribution on GTS and internal Environment Canada circuits on 4 January 2005. The Canadian AMDAR messages are distributed by the Canadian Meteorological Centre as BUFR FM94 bulletins. Real-time horizontal and vertical skew-T and tephigram representations of the Canadian AMDAR data have been available from the NOAA's Earth System Research Laboratory automated aircraft data web site (http://amdar.noaa.gov/java/) since 12 January 2005. In parallel, proof-of-concept AMDAR alternative systems for First Air, Canadian North and the smaller air carriers are being

developed and WestJet is about to join the program. The First Air system uses the TAMDAR unit.

Progress on the development of the Canadian AMDAR Program and plans for the future will be presented.

1C2.3
Performance de Scribe lors d'événements significatifs/ Performance of Scribe in significant weather
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Une étude réalisée sur le Québec durant période hivernale du 1er novembre 2004 à la mi-avril 2005, tente pour une première fois de fournir une véritable mesure de la performance de Scribe lors des événements significatifs. Pour ce faire, tous les avertissements météorologiques diffusés par le Centre des Intempéries de Montréal, de même que toutes les prévisions proposées par Scribe et, répondant aux critères d'avertissements ont été soigneusement comparés aux observations. La présentation s'attardera principalement sur les performances de Scribe confrontées à celles du météorologue pour chaque types d'avertissements météorologiques. Elle tentera aussi de fournir des explications aux lacunes respectives des protagonistes.

A study performed over Quebec during the winter season of November 1st, 2004 to April 15, 2005, attempts for the first time to provide a performance measure of Scribe in significant weather events. In order to achieve this, all the weather warnings issued by the Montreal Storm Prediction centre, as well as all the forecasts proposed by Scribe, both meeting warning criteria were carefully compared to the observations. The presentation will compare the performances of Scribe to those of the forecaster for each type of warning, trying to provide explanations for the weaknesses of each protagonists.

4DPA6.23
A study of the heat island formation and its effects using the MC2AQ model
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A study of the heat island formation and its effects using the MC2AQ model

Jenny Z. Liang, Diane V. Michelangeli and Paul Makar *
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The temperature difference between urban and rural areas is referred to as a "heat island". A heat island is largely caused by the amount of anthropogenic heat released into the atmosphere per year, and has significant impact on air quality, local weather and the climate. Although heat islands have been extensively studied, their surface-related effects, gas phase chemistry and aerosol chemistry in the urban environment have not been completely understood. In this study, the MC2AQ model is modified by introducing population-weighted anthropogenic heat flux values. The MC2AQ model is a 3-dimensional regional on-line air quality model, which includes the gas phase chemistry and aerosol formation. This model allows us to study a more complex system and obtain more reliable results.

The anthropogenic heat flux field can be incorporated into MC2AQ's existing

force-restore parameterization as a source term in the surface heating equation. Results show that the anthropogenic heating significantly affects the surface temperature, pollutants concentration and distribution. First we conducted a heat flux sensitivity test. It was found that anthropogenic heating causes the surface temperature to be 2 degrees higher in the urban area compared to the surrounding non-urban area. As a result, the secondary organic particles are more easily transported to the upper atmosphere, because of a reduction in the temperature inversion, and the simulated ozone concentration increases about 10 ppb at ground level. Then we will further investigate the effects of anthropogenic heating in Montreal and Toronto at 21km and 5.3km resolutions. The simulated results will provide detailed information on pollutant distributions, temperature profiles in the urban areas.

4DPA6.26
Effect of Anthropogenic Aerosols on Cloud Microphysics during the APEX-E3 field Experiment
Rodrigo Munoz-Alpizar , Jean-Pierre Blanchet , Eric Girard
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An explicit mixed phase cloud microphysical scheme, embedded into the Northern Aerosol Regional Climate Model (NARCM), is used to study cloud-aerosol interactions over est Asia during the APEX-E3 Experiment. The microphysical scheme assumes bulk microphysics as a double-moments scheme with three modal categories: cloud liquid droplets, pristine ice crystals (<100µm) and larger precipitation crystals (>100µm). It includes the following processes: ice crystal nucleation (homogeneously and heterogeneously), crystal growth, aggregation, evaporation, and sedimentation. NARCM take in to account for several aerosol processes by mean of the Canadian Aerosol Module (CAM). One-way nesting simulations (45, 9, 1.8 and 0.36 km) were performed during March to April 2003. At lower resolution, NARCM uses Lohmann's cloud scheme, but at resolution below 3km, the NARCM-CRM switches to the detailed microphysical scheme. NARCM model was drive with ECMWF data (0.4° resolution) at 45 km resolution. Aerosols simulations show that particles, composed principally of sulfates, were advected from the heavy industrial region of the East Asia by synoptic circulation. It suggests that during the studied period, the entire area around Japan had a mixed air mass of aerosol sulfates and other aerosols such as carbonaceous and sea-salt aerosol, supported by satellite remote sensing observations (MODIS retrieval) in the region. Detailed cold clouds (and mixed phase clouds) high resolution simulations were verified against in situ measurements. Result shows an encouraging agreement between the model simulation and observations. Research is continuing to improve CRCM-CRM scale transition, coupling aerosols-clouds into different conditions over the Arctic.

2C2.5
Extreme Rainfall in Ontario: The July 15 2004 Peterborough Storm
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Record breaking monthly wet conditions were observed in Peterborough during July 2004. Although significant rainfall occurred prior to July 14 as well as after July 15, the majority of the rainfall leading to the record setting monthly totals fell during the memorable storms of July 14-15 when extreme rainfall led to widespread significant flood damages and a state of emergency being declared by the City. The heaviest rainfall occurred during the early morning hours on July 15 as a cluster of intense thunderstorms developed and remained nearly stationary over the City of Peterborough. The rainfall amount and intensity were unprecedented in the observed Peterborough climate station record, with up to 240 mm of rain recorded over the 24 hour period from 8 AM on July 14 to 8 AM on July 15. However, much of this rain fell within the intense

thunderstorms during a 6 hour period early on July 15, with approximately 87 mm and 150 mm recorded during 1 and 2 hour periods, respectively.

The Peterborough storm study investigated several important issues, including:
- density of rain gauge network required to capture such events
- accuracy of radar rainfall estimates for such events
- statistical assessment of the return periods of high impact short duration and daily rainfalls
- need for updating of climatic design criteria used, for example, in planning storm water infrastructure

2DPA5.11
Evaluation of empirical functions for respiration in the young jack pine forest.
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In interpretation of the eddy covariance measurements of the carbon dioxide flux between atmosphere and surface ecosystem, the evaluation of the respiration contribution of the measured net flux is commonly used for partitioning the flux into assimilation and respiration components. It is generally accepted that the measured night-time fluxes (representing respiration) over forest may be approximated as an exponential function of the soil temperature. This type of empirical formulation is used for the gap-filling procedure in experimental CO2 flux data series (to calculate the annual flux estimate) as well as in a number of ecosystem models to account for heterotrophic respiration. We tested the exponential formulation on the eddy covariance flux data collected over the young jack pine forest in 2001-2005 at the BERMS (Boreal Ecosystem Research and Monitoring Sites) HJP94 (Harvested Jack Pine 1994) site. Our presentation will show that the standard empirical formulation fits poorly the data covering dry period (2003) and wet period (2004). The data also show significant deviations from the empirical formula at high temperatures (>16oC). The suggested hypothesis is that undeveloped canopy of the young forest is not capable to preserve the moisture in a soil and an effect of soil drying is modifying the respiratory function. This presentation will also examine alternate models of respiration which include soil moisture effects.

1DPA2.18
Generating continuous MODIS data sets over Canada at 250m spatial resolution at CCRS with new technology
Alexander Trishchenko [1], *Yi Luo* [5], *Konstantin Khlopenkov* [4], *Richard Fernandes* [3], *Rasim Latifovic* [2]
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Moderate Resolution Imaging Spectroradiometer (MODIS) onboard Terra and Aqua satellites is a unique sources of rich spectral information useful for many applications. The standard data MODIS data processing system implemented at NASA Distributed Active Archive Center (DAAC) cover basic operational needs for a number of data products. Implemented globally this system, however, cannot always achieve the best quality of data processing required for regional climate change applications. To provide data of improved quality, the Canada Centre for Remote Sensing with support from the Canadian Space Agency has initiated development of new technology for processing MODIS imagery at 250m spatial resolution. National scale data products are produced from the level 1B top of the atmosphere reflectance swath imagery. A new reprojection and compositing package has been developed to address MODIS bow-tie effect. The CCRS

technology preserves the original spatial resolution and provides high accuracy and consistency of pixel georeferencing required for satellite climate data records. Further details of data processing technology will be presented and examples of national imagery for various seasons will be given.

2C2.6
Evaluation of Precipitation from Weather Prediction Models Using Observations From Radars and Satellites
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We compare quantitatively precipitation from numerical weather prediction models, radars and satellites. The models are tested over the continental US. Conventional statistical skill measures (probability of detection, false alarm rate, critical success index) are examined, and scale decomposition methods and frequency analysis are used for the evaluation. The precipitation data are obtained from two Canadian and US operational models, and from the composite radar network and GOES satellite. The data consist of hourly precipitation accumulation over 21 days during the summer and fall of 2003-04 over a 2,160 km × 2,160 km domain in the central and eastern US.

The scale decomposition analysis using wavelet and Fourier methods shows satisfactory agreement between models and observations (radar and satellite) only at the large scales. At small scales, the models' power spectra decay much more rapidly in comparison with the observed power spectra. A significant trend of falloff of power of model spectra starts at scales that are approximately 10 times larger than the model horizontal resolution. A lag correlation analysis performed in the spectral domain shows that the models have a similar behavior with wavenumbers as the observations. The correlation at small scales is much weaker than at the larger scales.

Precipitation fields are also analyzed in the frequency domain through histograms of precipitation intensity for a given bin width. In addition, model skill scores based on conventional categorical measures are examined, showing near constant skill over a 24-hour forecast. The scores have also been compared to those of short term advection-based radar nowcasts. After a forecast lead time of about 6 hours, the models show a higher skill than the radar nowcasts.

1C2.4
Current status and future improvements in the Canadian Meteorological Center's operational numerical weather prediction suite
Yves Pelletier , Lewis Poulin , Paul Pestieau
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The Canadian Meteorological Center (CMC) runs, in a fully operational production environment, the models and analysis systems that have been developed by the Development Divisions of CMC along with MSC's research groups. The current status of the operational forecasting suite will be reviewed. Significant improvements were introduced in the past year. They include:

- Changes to the CHRONOS air quality forecast model (July 2005)
- Modifications to the ocean Wave Forecast System (July 2005)
- New GEM LAM 2.5 km experimental runs installed over western and central Canada domains (August 2005)
- Major improvements to the Ensemble Prediction System (December 2005)

Improvements to the operational system planned for the upcoming year will be presented. These include a report on the ongoing implementation of the new GEM 35 km Meso-Global model as

well a series of follow-up improvements. Further planned changes or additions to the operational production suite will also be discussed.

We will also provide an update on CMC operational products including those available on the interface called Vizaweb (web browser to view NWP output images) and the availability of new CMC GRIB data products to external users.

1B3.4 **INVITED / INVITÉ**

Eddy amplitudes in baroclinic turbulence-driven by non-zonal mean flow: Shear dispersion of potential vorticity

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As in the midlatitude atmosphere, midocean eddies are primarily generated by baroclinically unstable mean currents. In contrast to the atmosphere, however, oceanic currents are significantly non-zonal. Even weak non-zonal currents are linearly unstable, since beta does not suppress growing meridional waves. Theories for the nonlinear equilibration of baroclinic instability, and hence theories for the amplitudes of midocean eddies, must therefore take into account the different dynamics of non-zonal flow. It is shown here that the amplitude of fully developed baroclinic turbulence due to non-zonal shears differs from that due to zonal shears primarily in the nature of the eddy generation. Since beta will act to create large-scale zonal elongation regardless of the generation source, the structure of the eddy velocities in the zonal and meridional directions are fundamentally different, the former being jet-like, and the latter being nearly random and isotropic. Thus the flux of potential vorticity in each direction (equivalent to the eddy energy generation rate) occurs through different processes. The cross-jet mixing has been shown previously to obey a mixing-length scaling, and this corresponds to the generation due to unstable zonal flow. The along-jet mixing, which corresponds to the generation due to the meridional shear, is shown here to be a best described by a shear dispersion model. The resulting flux is orders of magnitude higher than in the cross-jet direction, and thus eddy energies driven by baroclinically unstable mean flows with a non-zero meridional component are much larger. This provides an explanation for recently reported results on the matter. Moreover, given recent observational and modeling studies showing the ubiquitous presence of zonal jets in the oceans, the results presented here indicate a powerful source of eddy energy.

3DPA1.11

The 2.5 km horizontal resolution limited area version of the global environmental multiscale model

Amin Erfani [1], *Jocelyn Mailhot* [2], *Sylvie Gravel* [2], *Michel Desgagné* [2], *Neil McLennan* [5], *Jacob Denis* [4], *Ron Goodson* [3], *Patrick King* [2]
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The Canadian Meteorological Centre and the Meteorological Research Division of Environment Canada have been working in collaboration with representatives from the Pacific and Yukon, Prairie and Northern, Quebec and Ontario regions to develop a 2.5 km resolution version of GEM-LAM (Limited Area Model), centered at various locations within Canada, for use in operational applications. Since summer of 2005, two LAM windows, one over southern British Columbia and the other over southern Ontario and Quebec, have been running in an experimental operational mode to provide a daily 24 hours forecast. The two LAMs are initialized by the 12 hours forecast of the 00 UTC regional operational GEM which also provides the needed

boundary conditions at every hour. This presentation will provide an update on the development of the GEM-LAM at 2.5 km resolution, and present plans for future work.

2B1.1 **INVITED / INVITÉ**

Stratosphere-troposphere dynamical coupling

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This talk will discuss mechanisms for dynamical coupling between stratosphere and troposphere. Particular topics to be addressed will include (a) whether it makes sense to think of stratospheric 'cause' and tropospheric 'effect', (b) the coupled role of eddies and mean flow within the troposphere and within the stratosphere and (c) the distinction between downward propagation of information within the stratosphere itself and the link between lower stratosphere and troposphere.

1DPA2.21

Recent Results from the MAESTRO UV-Visible Spectrophotometer on Board the Canadian Science Satellite - SCISAT

C.T. McElroy [1] , J. Kar [2] , J.R. Drummond [2] , C. Nowlan [2] , J. Zou [2] , C. Midwinter [2] , D.V. Barton [1]
(Presented by / Présenté par ***Tom McElroy***)
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The MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) spectrophotometer was launched on board the ACE (Atmospheric Chemistry Experiment) satellite in August of 2003. This Canadian science satellite was designed specifically to investigate the chemistry of the Arctic ozone layer during the late winter and early spring when ozone depletion takes place. The combined instrument complement of an infra-red Fourier Transform Spectrometer (ACE-FTS) and the MAESTRO spectrometer are making a comprehensive, simultaneous measurement set of the chemicals in the stratosphere that control ozone depletion.

MAESTRO comprises two diode array, concave, holographic diffraction grating spectrometers covering the spectral regions 270 to 550 nm and 525 to 1000 nm. It is making measurements in both the occultation and backscatter observing modes. Operational products from the instrument include nitrogen dioxide, ozone and aerosol extinction. This paper will describe the MAESTRO instrument and its operational data analysis algorithms and will present some recent constituent profile results.

3DPA2.2

Climate Historical Archives in Downsview (CHAD)- Content and Access

Anna Deptuch-Stapf , Phil Jarrett
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MSC maintains an archive of historical climate information. To facilitate access to these valuable resources an electronic inventory of the archive's contents has been created. This includes listing of different series of meteorological original forms, maps, historical documents and historical climate data logs available on different media. Inventoried media include digital images, microfilms, microfiches, photos, diskettes, CD as well as paper forms and old data logs. The series of developed Web based tools allows search and retrieval of the stored materials.

Further projects are underway to provide easy access to other climate historical material, like historical weather maps and original meteorological forms, to the research and professional communities.

Presentation will concentrate on tools and contacts available for the user to access resources of Climate Historical Archive in Downsview.

1DPA2.14
Assimilation of GPS Radio Occultation observations
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We have tested the impact of the assimilation of GPS Radio Occultation observations. With GEM's operational version as a reference, we have adapted it to accept the refraction index profiles that can be measured through radio occultation. The CHAMP and SAC-C satellites have now produced several years of data after their launch in late 2001. Despite the moderate density of profiles, about 300/day worldwide, an observable positive impact in GEM's performance can be detected through several indicators. Besides a small general improvement everywhere, the southern stratosphere appears to be particularly better described after GPSRO assimilation.

In general, the results are encouraging towards the availability in the forthcoming months of data from the COSMIC project. This is a constellation of 6 satellites, launched in spring 2006 and that will provide an order of magnitude more profiles/day than CHAMP, and will be available in near real time.

1DPA1.10
ELBOW 2001: Generation of a Low-Level Mesoscale Boundary Inventory
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The Effects of Lake Breezes On Weather (ELBOW) 2001 project was conducted in the summer months of 2001 in Southwestern Ontario. Low-level mesoscale boundaries were identified for each hour of each day from June 1 to August 31. These boundaries included lake breeze fronts, land breeze fronts, thunderstorm outflow boundaries, 'hybrid' boundaries, 'merged' boundaries and 'other' boundaries.

Boundaries were identified in Aurora using four different analysis techniques: radar analysis, mesonet analysis, satellite analysis, and integrated analysis. The mesoscale boundaries in the radar analysis were identified using the Exeter radar radial velocity and reflectivity images. GOES-8 visible satellite images were used in the satellite analysis. The mesonet analysis used data from surface stations in the region (including 14 stations set up for ELBOW). The integrated analysis made use of all these data sets, viewed both individually and simultaneously.

After the four analyses were completed, a final boundary set was produced. This final 'truth' set considered all the boundaries, from all four analyses, and all data sets. The four analyses were statistically compared to the final boundary set in order to distinguish which techniques are the most accurate and useful for mesoscale analysis.

The ELBOW final mesoscale boundary inventory is currently being used for nowcasting, severe weather and air quality studies.

1DPA2.23
SWIFT Instrument Performance and Algorithm Development

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The Stratospheric Wind Interferometer For Transport studies (SWIFT) is a Canadian satellite instrument designed to measure stratospheric winds and ozone concentration to improve our knowledge of the dynamics of the stratosphere and the global distribution and transport of ozone. The SWIFT instrument is an imaging, field-widened Michelson interferometer.

SWIFT recently completed a successful instrument Phase B Study and is about to enter Mission Phase B/C Study by the Canadian Space Agency (CSA) for deployment as the primary instrument on the Chinook Mission scheduled for launch in 2010.

This paper describes the current instrument design and the wind and ozone retrieval algorithm. Sample simulation, error analysis and data retrieval results are presented.

3DPA2.10
Designing Quality Representation for Environment Canada Radar Products
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In the last decade there has been an increasing worldwide realization that operational weather radar products should be accompanied by some representation of data quality. Unfortunately, there are multiple sources of errors with quite different properties, and errors can impact different products in different ways. Quality is affected by technical factors, such as radar calibration, propagation factors, such as attenuation, and meteorological factors such as drop size distribution or vertical evolution beneath the radar beam. Algorithms to correct radar sampling issues will themselves introduce new uncertainties. While work is being done on individual error sources, and their impact, the result is a heterogeneous collection of interrelated climatological, statistical and empirical assessments. It is not clear how to integrate them together.

Currently Environment Canada's radar products are missing even basic quality representation. At the opposite extreme it has been estimated that a complete error representation would see each radar datum accompanied by 30 to 50 quality measures. Work is underway to develop EC radar products with a single quality index. Initially the measure will be an ad hoc mixture of major factors, but the design attempts to leave room for a more careful inclusion of quality estimates.

3C4.3
Vertical structure of estuarine circulation in the Gulf of St. Lawrence
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The Gulf of St. Lawrence is a large estuarine system wherein gravitational circulation at depth is driven by freshwater forcing from the continent, but we still cannot quantify this relationship. We examine detailed 3D fully prognostic simulations of the sea ice – ocean conditions over a recent 7yr hindcast period. The model solutions are compared to a broad range of available observations on the variability of water mass momentum, heat, salinity and phase budgets. We examine the volume transport at the mouth of the Estuary as function of depth and freshwater forcing. Generally the synoptic to sub-monthly transport variations are two to three times higher than the mean, and the seasonal cycle is of the same order of magnitude. The simulations reveal the large seasonal cycle in the formation and circulation of the winter mixed layer in the Gulf and

its springtime intrusion in the Estuary. The mean (17mSv) freshwater outflow drives 105mSv mean outflow in the 0-30 m depth range and 72mSv inflow in the 30-150m range (both maximum during spring and summer), and an inflow of 16mSv (maximum during fall and winter) at depth >150m. The intensity of the estuarine circulation is well correlated and a linear function of runoff on seasonal time scales (r=64). Stabilization experiments with a reduction of 10% in river runoff (experiments were conducted through 40% reduction) is associated with 6% inflow reduction in the intermediate range, but increased inflow by 5% in the deeper waters. The dynamics and consequences of these new results are discussed in the light of mixing intensity in the seasonal modes of circulation, detection, and the hydrological past conditions and scenarios for the Great Lakes and St. Lawrence River flows.

1DPA1.14
Vérification du temps significatif hivernal/ Verification of Significant Winter Weather
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Depuis 2 ans, un travail de vérification des avertissements météorologiques émis durant la saison hivernale est menée au Québec. Initialement, l'expérience cherchait à évaluer dans quelle mesure cette tâche fastidieuse peut-être automatisable. Pour compléter le réseau d'observations météorologiques d'Environnement Canada, le réseau coopératif en partenariat avec plusieurs organismes provinciaux tels que Hydro-Québec, Alcan, SOPFEU,… de même que les données climatologiques du MDDEBQ et finalement, les données de l'état des routes du ministère des Transports du Québec ont servi à l'étude.

Une telle base de données apporte certes, une vision plus juste des événements météorologiques mais elle suscite parfois des inconsistances qui peuvent s'avérer difficile à diagnostiquer dans une vérification automatisée. Le poster a pour but d'identifier les embûches potentielles à la vérification des événements synoptiques hivernaux. Plusieurs graphiques et tableaux des résultats de la vérification ont été créés avec le soucis de susciter de l'intérêt et seront affichés sur le babillard.

3DPA3.1
Assessing radar reflectivity retrieval methods with in-situ observations of cloud hydrometeor spectra
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(Presented by / Présenté par ***Monika Bailey***)
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Cloud properties are inferred from ground and satellite radar measurements using retrieval methods that assume a relationship of radar reflectivity to particle size distributions. In-situ aircraft measurements are used to validate these methods. Radar reflectivity is proportional to a power (typically 3.8 to 4.8) of the instrumentally determined particle size. This implies that a few large particles can dominate the reflectivity. For example, more than 50% of the cumulative reflectivity calculated from spectra for ice clouds comes from particles with sizes between 6.4 and 12.8 mm. It is therefore very important to accurately characterize this part of the spectrum.

The goals of this study were to:
1) Examine recorded particle size spectra to determine how often radar reflectivity is contributed by large particles.
2) Estimate this contribution by fitting a gamma distribution to the spectra and extrapolating beyond the largest measured particle size.

Data from 97 research flights (34,000 km of in-cloud data) were examined. Particle concentrations and dimensions were measured with three PMS 2D probes.

A gamma distribution was fitted to the large particle tail of each observed particle size spectra and the missed reflectivity was calculated by extrapolating beyond the largest observed particle size. Preliminary results suggest that although up to 15% of 30 second spectra are missing some reflectivity, significant missed reflectivity (> 5db) occurs in less than 1% of measured in-cloud observations. The dependence of these results on temperature range, cloud phase and averaging time interval will be discussed.

4DPA6.31
Monitoring Farm Gas Emissions by bLS
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We demonstrate the usefulness of an inverse-dispersion technique to measure gas emissions from farms. The technique combines a measurement of gas concentration downwind of the farm, with dispersion model calculations to allow the inference of emissions. A backward Lagrangian stochastic (bLS) dispersion model is used for this calculation. The simplicity of the technique makes it possible to study gas emissions in situations that are otherwise inaccessible (practically). Here we show how the bLS technique was used to examine how the production of methanol from animal waste changes the methane, ammonia, and odor emissions from a traditional farming system. Measurements were made from farms that divert animal waste to methanol-production, and from traditional farms were waste is accumulated and evaporated. We found that while the methanol production farming system reduces total methane emissions, it increases ammonia emissions.

3B1.7
Additions to the MSC's National Climate and Information Archive from Environment Canada and partner networks
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Over the last few years, changes in the Meteorological Service of Canada's (MSC) weather and climate networks have had a direct impact on data availability for the public. The MSC monitors the state of the atmosphere, hydrosphere, and cryosphere. The National Climate and Information Archive concentrates on archiving data from MSC operational monitoring networks and ensures accessibility of these data.

Recently, new data have been added to the archive. In addition, Environment Canada has also made more data available for the general public via its Climate Archive Online website. Now, more than ever before, the public has access to additional data that is even more readily available.

The Doppler Radar Archive Project, completed this year, adds volume scans and image data to the MSC digital archive and will be available on the Internet in 2006.

New elements from the Hourly Aviation network include altimeter setting, new cloud layers, obscuring phenomena, wind character and wind gust speed. Twenty-five new Reference Climate Station (RCS) elements pertaining to precipitation, wind, and solar radiation were also added.

The Canadian Upper Air Observing Program includes the Upper Air network and the Canadian Aircraft Meteorological Data Relay (AMDAR) Program. New Upper Air elements are wind speed, wind direction, altitude above sea level, and pressure. Some messages also contain relative

humidity and temperature. The AMDAR network provides aircraft position, wind speed, wind direction, temperature, and in some cases humidity, turbulence and icing.

There are future plans to add other observed weather and climate elements to the archive.

4DPA8.9

Nonlinear Internal Waves on the Central Mexican Pacific Coast

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This paper studies temperature fluctuations at the internal wave spectral band from moored instruments on the central Mexican Pacific Shelf. It is observed that for the spectral band $f <<$. $<< N$, where N is the buoyancy frequency and f is the inertial frequency, the spectral falloff rate with frequency . tends to $^{-3}$. These spectral features are simulated by the model spectrum of non-linear internal waves (MSNIW) in the shallow sea. It is shown that non-linear internal waves with frequencies $f <<$ $<< N$ are governed by the modified simple wave equation, which underlies the MSNIW on the shelf. The spectral model shows a $^{-3}$ falloff rate with frequency, in contrast with the spectral model proposed by *Garrett and Munk*, which shows a $^{-2}$ falloff rate.

3DPA1.5

Modulation of midlatitude storm structure and intensity due to impacts of wave drag and sea spray

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A coupled atmosphere –wave – sea spray model system is used to evaluate the combined impacts of spray evaporation and wave drag on midlatitude storms. Our focus is on the role of air-sea fluxes on storm intensity and development, and related impacts on the structure of the atmospheric boundary layer. The composite model system consists of the Canadian Mesoscale Compressible Community (MC2) atmospheric model coupled to the operational wave model WaveWatchIII (WW3), and a recent bulk parameterization for heat fluxes due to sea spray. Case studies are extratropical hurricane Earl (1998) and two intense winter storms from 2000 and 2002, hereafter denoted Superbomb and Bomb, respectively. Results show that sea spray tends to intensify storms, whereas wave-related drag tends to de-intensify. The mechanisms by which spray and wave-related drag can influence storm intensity are quite different. When wind speeds are high and sea surface temperatures (SSTs) warm, spray can significantly increase the surface heat fluxes. By comparison, momentum fluxes related to wave-drag are important over regions of the storm where young, newly generated waves are prevalent, for example during the rapid-development phase of the storm, and decreases in areas where the storm waves reach maturity. We show that the collective influence of spray and waves on storm intensity depends on their occurrence in the early stages of a storm's rapid intensification phase, and their spatial distribution with respect to the storm center. Moreover, for the case of Superbomb, we use a potential vorticity framework to show relative importance of these surface flux impacts compared to baroclinic processes.

3DPA2.16

The Future of Quality Assurance and Quality Control of the Meteorological Service of Canada's Monitoring Data

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Quality Assurance (QA) and Quality Control (QC) are integral aspects of a comprehensive data management system. QC procedures, through various error detection methods, ensure that monitoring data from the Meteorological Service of Canada's (MSC) networks meet defined standards and support the QA process of problem resolution and continuous improvement.

The MSC collects, quality controls, archives and distributes meteorological, hydrometric, and air quality data from various monitoring networks across Canada. Currently, there are constraints to having a comprehensive and integrated data management and QA system due to the existence of multiple databases, message formats, QA/QC systems/standards, algorithms and flagging schemes across the Service. In addition, reduced resources available to perform manual QA/QC, as well as ever-increasing data volumes (due to advancing monitoring technology, and expanded MSC partnerships), have hastened the necessity to modernize the MSC's data management system.

A project is currently underway to institute a new Data Management Framework (DMF) for the MSC. The DMF project will harmonize many of the QA/QC systems, databases and procedures currently employed regionally and/or on a network-by-network basis. The DMF will also simplify the incorporation of data from many different sources, allowing automatic QA/QC systems to perform QC techniques which were previously too complex to attempt, or not possible.

This presentation will outline some of the current QA/QC challenges and issues facing the MSC, as well as describe the proposed improvements and features which will be achieved through the implementation of the DMF.

3DPA3.18

Influence of La Primavera forest on the climate of the tropical mega city of Guadalajara, Mexico

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The results of the climatic relations between the forestall area of La Primavera and the Metropolitan Zone of Guadalajara (MZG) are discussed. This is important because this forest is the closest green area of the city and the only one. It is shown that the MZG had a significant size increment during the middle second of the past century, reaching a size compared to the forest and it is currently beginning to surround it. Further, long spatial-temporal series of the meteorological parameters measured in the study area were analyzed. Using the cross-spectral analysis technique, the relations between the meteorological variables and the study areas are displayed in two frequency bands: low (from one to 20 years) and high (from some hours to

several days). Based on our work, we conclude that La Primavera plays a very important roll in the development of the characteristics of the urban climate of the MZG.

1B3.1 **INVITED / INVITÉ**

Baroclinic Turbulence Revisited

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The standard paradigms of baroclinic instability -- the necessary conditions, weakly nonlinear equilibration, and adjustment to criticality -- may not apply well to atmospheric and oceanic flows. We discuss recent studies of baroclinic instability in non-zonal flows and in time-dependent background flows and show that these situations can lead to significant eddy generation and maintained turbulence even with very weak large-scale shears.

4C3.7

Modeling studying on ice formation by bacteria in warm-based convective cloud

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Bacteria have been recognized as cloud condensation nuclei (CCN), and certain bacteria, commonly found in plants, have exhibited capacity to act as ice nuclei (IN) at temperatures as warm as -2 ºC. These ice nucleating bacteria are readily disseminated into the atmosphere and have been observed in clouds at altitudes of several kilometres. It is noteworthy that over 20 years ago, one assumed the possibility of bacterial transport and their importance into cloud formation process, rain and precipitation, as well as causing disease in plants and animal kingdom. We used a 1.5-D cumulus cloud model with the CCOPE 19th July 1981 case and the observed field profile of bacterial concentration, to simulate the significance of bacteria as IN through condensation freezing and immersion freezing mechanisms. Based on the concentration of ice active bacteria between -3 °C and -8 °C, ice active bacteria should have a great influence on the ice crystal multiplication process. This may have significant implication in understanding of climate. In this paper, we will present our results on the role of bacteria as active ice nuclei in the developing stage of cumulus clouds, and their potential significance in atmospheric sciences.

3DPA3.17

Developing a daily agro-climate interpolation grid for Canada : data verification and model validation

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The use of daily climate data in agriculture has increased considerably over the past two decades as a result of the rapid development of information technology and the need to assess risk of future extreme weather due to climate change. Such events have the potential to impact agricultural production and environmental sustainability affecting soil, air and water resources. We describe the construction of an agroclimatic database of high spatio-temporal resolution (i.e.,

daily, 10 km) with coverage across agricultural regions. Daily meteorological station data of precipitation and temperature (Tmin, Tmax) for the period 1961-2003 is interpolated according to three models (ANUSPLIN, HYBRID and DAYMET-US). We present interpolation results and selected results from verification analysis. This database is intended for use by a wide range of end users concerned with agricultural management, planning, and policy. Users will be provided with an assessment of changing probabilities in precipitation and rainfall required to plan adapt infrastructure, crop breeding, and policy issues in agriculture over a horizon of 20 to 30 years, with emphasis is placed on risks from seasonal and extreme climatic events. Potential application of this database also includes numerical grid computation to simulate effects of climatic variability on ecosystem biogeochemical cycling across spatial and temporal scales. This talk will also highlight the use of Geographical Information Systems (ArcGIS) and plans for integrating it within the decision-support tool for interactive mapping, and generating scenario forecasts.

3DPA2.7
Monitoring Waves and Coupling Processes at the Polar Environment Atmospheric Research Laboratory (PEARL)
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At 80 degrees north, the PEARL provides a unique perspective on the processes which couple different heights and geographic regions. To focus effort in this direction one of the science themes developed for the PEARL facility is the Waves and Coupling Processes theme. While the climatological seasonal cycle of temperature in the polar middle atmosphere is well know, the identity and form of the wave motions and their impact on this region of the atmosphere are still being established. Observations from the PEARL in combination with models and observations from other polar sites will be used to identify the characteristics of the planetary waves, tides and gravity waves above the observatory and correlate amplitude variations with season and the large scale dynamical conditions at the time. Particular attention will be paid to the development of the polar vortex and associated phenomena and the relationship between wave signatures seen in wind, temperature, and constituents at various times of the year. Instruments being installed at the PEARL which are important to this theme include the E-Region Wind Interferometer, the meteor radar, the Spectral Airglow Temperature Imager the PEARL All-Sky Imager, the ozone and Rayleigh/Mie/Raman lidar, the VHF and cloud radar, the Fourier Transform Spectrometer and the Atmospheric Emitted Radiance Interferometer. In this presentation the current status of activity associated with this theme and the planned science activities will be described.

4DPA6.11
Using a single pass tunable diode laser for measuring ammonia volatilization following biodigested dairy manure application in a field
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A single pass close path tunable diode laser (TDL) was used in combination to the flux gradient technique for measuring ammonia (NH_3) volatilization in a harvested field which received biodigested dairy manure. The ammonia laser was running at at 91.8K, 659mA and was connected to a reference NH_3 cylinder of 3.75%. The air was sampled at two heights separated

by 1 m. A valve was switching every 10 s between the two inlets to bring the air under vacuum to the TDL sampling cell, without being dried. The detector was also crycooled. The TDL was operated continuously in conjunction with an eddy covariance system. The magnitude of livestock manure ammonia emissions measured by the TDL was compared for few periods with daytime ammonia fluxes measured using the relaxed eddy accumulation technique equipped with denuder tubes. The denuder tubes were coated with oxalic acid as a trapping medium. The flow rate was set at 2 L min^{-1}. The 60-cm long denuder tubes were extracted with 3-10 mL of deionized water. The NH_4^+ concentration in water was analyzed by ion chromatography by Environment Canada Moncton. Both techniques exhibited the same emission pattern with highest peaks of 700 ug NH_3-N m^{-2} h^{-1} obtained on the first day. On the following day the fluxes were in the range of 100-200 ug NH_3-N m^{-2} h^{-1} for both approaches. By the third day, NH_3 fluxes were negligible. Results show that the single pass TDL is suitable for measuring ammonia under these conditions.

4B1.6

Impact of cloud processing on eastern North American regional aerosols during the ICARTT field campaign in summer 2004: A Modelling study

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During the summer of 2004, a major field campaign was conducted over the eastern North America, the North Atlantic, and western Europe under the coordination of the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT). An unprecedented amount of measurements was made from various mobile platforms as well as surface-based sites during the campaign to characterize atmospheric trace gases and aerosols in eastern North American regional plumes and continental outflows. Environment Canada's participation in the field campaign was an aircraft study (NRCC Convair 580) focused on chemical transformation and transport by clouds and transport into the Maritimes.

The summer of 2004 was dominated by unseasonably cool and wet weather over the eastern North America. Observations during ICARTT indicate that the regional aerosols were highly processed. One question to ask is how much of this is due to processing by cloud. In this study, we use a comprehensive regional air quality model AURAMS (A Unified Regional Air-quality Modeling System) as an integrative tool to investigate the influence of cloud processing on eastern North American regional aerosols observed during the field campaign. Model simulations are carried out for a five-week ICARTT model evaluation period. In this paper, we will first present some of the results from an evaluation of model performance in representing cloud processing, based on comparison with observations conducted on the Convair 580. We will then discuss the influence of cloud processing on the physical and chemical characteristics of the regional aerosols during ICARTT field campaign, based on model sensitivity study and budget analysis.

3C3.6

Impact of misspecification of wind forcing error covariance in 4DVAR analysis to an estimation of mid-latitude basin scale ocean circulation

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It is generally accepted that standard re-analysis wind stress data sets used widely in hindcasting studies contain erroneous components. However, their impact on estimated ocean circulation is not well understood. In this study, we investigated the response of the sea level anomaly (SLA) field of a midlatitude basin scale ocean to a pseudo wind stress error simulated from a simple covariance function with a 1 year period. Using Monte Carlo experiments, the sensitivity of SLA

variance to a one of the most unknown parameters in the covariance model, horizontal decorrelation length scale, was studied. The SLA variance due to the wind stress error shows strong sensitivity to the decorrelation length scale within the range of 100km to 750km and the variance converges beyond that range. The existence of this sensitivity can be explained by two layer linear quasi-geostrophic dynamics and attributed to a stronger response of forced Rossby waves to small wave number components in the wind stress curl error. The sensitivity of the ocean circulation estimated by 4DVAR analysis to an uncertain covariance parameter was also studied by twin data assimilation experiments.

1DPA4.4
Delayed response of the extra-tropical northern atmosphere to ENSO: A revisit
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Lag correlations between monthly mean tropical Pacific sea surface temperatures (ENSO signal) and 500-hPa geopotential heights are examined. As expected, significant ENSO impact on the extra-tropical northern atmosphere can only be found over the Pacific/North American (PNA) sector in the winter season. It is shown that the most remarkable atmospheric response occurs in February, with a well-defined teleconnection similar to the PNA pattern that can be related to the ENSO signal as early as in the preceding summer (June and July). Remarkable impact of the summer ENSO signal also appears over North America in March of the following year. The maximum correlation between the northern atmosphere in January and the preceding ENSO signal occurs when the ocean leads 1-4 months.

Possible dynamical mechanisms for the above-mentioned teleconnection are investigated. Given the limited memory of the atmosphere, it is difficult to explain the delayed response of the winter atmosphere to the summer ENSO signal using the "atmospheric bridge" theory alone. A preliminary analysis seems to suggest that the equatorial/coastal oceanic Kelvin waves are capable of carrying the summer ENSO signal to the northeastern Pacific in the following winter. The existence of such an “oceanic bridge” remains to be confirmed through further theoretical and modeling studies.

A straightforward application is to use the summer ENSO signal as a predictor for the winter climate along the South Coast of British Columbia. It could provide a valuable service to the 2010 Olympic Winter Games in Vancouver, which will be held in the month of February. A simple regression analysis indicates that the cross-verification skill of such predictor is encouraging.

3DPA5.5
Oxygen measurements on Argo floats
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As part of the Canadian Argo program, DFO deployed four APEX floats equipped with Aanderaa’s optode oxygen sensor in 2004: one in the northwest Atlantic Slope Water, one in the Labrador Sea, and two in the Gulf of Alaska. We will report on nearly two years of oxygen data from these floats, discussing issues of calibration accuracy and drift. We will also describe the annual cycle of oxygen for two floats that remained in fairly homogeneous water masses throughout the year: one in the oxygen-rich Labrador Sea, and a second one in the oxygen minimum zone of the Gulf of Alaska. Comparisons of Argo/Optode oxygen measurements with Winkler titrations for the first profile of the Gulf of Alaska float near station PAPA are very encouraging, with an average absolute difference as small as 6.2 µmol kg^{-1} (within

manufacturer's specifications). At 1900 m depth, there is no evidence of oxygen sensor drift over a period of 19 months in the Labrador Sea, and over a period of 17 months in the Gulf of Alaska.

4A1.1 **INVITED / INVITÉ**

Tropospheric chemistry from space

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Satellite measurements are presently transforming our observing system for tropospheric composition from chronically data-poor to suddenly data-rich. They are providing new information on emissions to the atmosphere, on the development of regional pollution episodes and the long-range transport of pollution, and on climate forcing by aerosols. However, observation of tropospheric composition from space is extremely difficult; only a limited suite of species can be measured and with coarse vertical resolution. We need new approaches to exploit the information content from the satellite measurements, and to enhance the value of these measurements through integration with in situ (surface and aircraft) observations. I will review the various approaches for space-based observation of tropospheric composition, and present results from work at Harvard analyzing data from sensors already in space (including GOME, MOPITT, MODIS, MISR, SCIAMACHY, TES, OMI). I will also outline some priorities for future missions.

3B3.2

Currents and Hydrographic Variability from Moored Measurements across the Scotian Slope in 2000-2004

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Results are presented from an array of three current-meter moorings deployed on the Halifax line across the Scotian Slope in 2000-2004. A mooring on the 1100-m isobath was maintained for much of June 2000 to April 2004, and on the 2000-m (300-m) isobath for much of June (October) 2001 to April 2004. The moored measurements were complemented by CTD profiles taken during semi-annual surveys as part of the Atlantic Zone Monitoring Program, with enhanced spatial coverage added over the slope. Seasonal and interannual variability in the currents, hydrography and transports are examined, together with the response to Gulf Stream influences and strong wind events. Seasonal-mean flows were southwestward (equatorward) at the 1100- and 2000-m sites with the primary exceptions of spring-summer 2002 and summer-fall 2003 when the flows in the upper 300m were directed northeastward associated with Gulf Stream rings intrusions. During these latter periods, flows over the entire water column at the 300-m site were directed northeastward suggesting that any equatorward flow of shelf-water occurred shoreward of the array.

2C3.6

Modeling net ecosystem exchange of North American ecosystems using satellite images and climate data: Vegetation Photosynthesis and Respiration Model (VPRM)

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We present the Vegetation Photosynthesis and Respiration Model (*VPRM*), a satellite-based assimilation scheme that uses Enhanced Vegetation Index (*EVI*) and Land Surface Water Index

(*LSWI*) from the Moderate Resolution Imaging Spectroradiometer (*MODIS*) plus eddy flux, sunlight, and air temperature data, to estimate the hourly, seasonal, and interannual variation of Net Ecosystem Exchange (*NEE*) of different biomes over North America. Within each of our 12 vegetation classes, the Gross Ecosystem Exchange (*GEE*) is represented using 1) nonlinear light saturating photosynthetic response 2) the EVI, which specifies the phenological properties of the fraction of photosynthetically active radiation absorbed by the leaf chlorophyll ($FAPAR_{PAV}$), and 3) the LSWI, which reflects changes in both leaf water content and soil moisture and accounts for the effect of leaf age on photosynthesis at canopy level. The Respiration (*R*) is represented using a linear model that depends on air temperature. Per vegetation class, 4 parameters were fitted to NEE data of 1-4 years duration at calibration sites to produce a model of hourly NEE that also resolves seasonal and annual scales. The model was then tested at validation sites.

Cross validations show that the 4 parameters of the VPRM have strong prediction ability for sites with similar vegetation from hourly to monthly scales, accounting for 60-90 % of the variance for hourly NEE. The VPRM reproduces partitioning of NEE into GEE and R without any complex algorithms or assumptions. The VPRM, as a bottom-up model, computes hourly surface fluxes for CO_2 at 1 km resolution across North America using available driver data; it also provides priors for high-resolution inverse model studies, with the potential to aid in understanding the causes and controls of seasonal and interannual variability in NEE in terrestrial ecosystems.

3A1.1 **INVITED / INVITÉ**

A brief history of climate change detection and attribution

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Madden and Ramanathan (1980) discussed the detection of a global warming signal due to increasing atmospheric greenhouse gases against a background of natural climate variability and concluded that an anthropogenic climate change signal should be detectable before 2000. A brief review will be presented of the main developments in the detection and attribution of climate change, including the basis for the IPCC conclusions in 1996 that “the balance of evidence suggests that there is a discernible human influence on global climate” and in 2001 that “most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations”. More recent developments, including the attribution of regional warming to anthropogenic forcing and extensions of detection and attribution methods to constrain projections of future climate change will be discussed.

1A1.2 **INVITED / INVITÉ**

Improving Warning Performance through Advances in Operational Training

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“The goal of any organizational learning is transfer of learning to desired performance that produces organizational results”
-Dr. Mary L. Broad, 2004
“Beyond Transfer of Training”

A core mission of the National Oceanic and Atmospheric Administration’s (NOAA’s) National Weather Service (NWS) to provide weather warnings to the public that are timely and accurate. The Warning Decision Training Branch (WDTB) addressed that mission by proving weather warning-related training to over 2000 National Weather Service forecasters, hydrologists, and support staff.

This presentation will provide an overview of the advances in severe weather warning training WDTB provided to these decision makers by addressing implementation of rapid E-Learning

techniques, harnessing field collaboration, integration of new development and delivery technology, and by tasking the key training stakeholders to fully participate in the operational training process.

The presentation will examine case studies from two Department of Commerce (DOC) award winning training initiatives to asses what key training features need to be addressed that will optimize the transfer of warning decision-making training into weather warning performance.

3DPA4.4
Ice Cover on the Saint John River at Fredericton, New Brunswick - Where did the ice go?
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Volunteers have recorded the annual freeze-up and break-up dates on the Saint John River at Fredericton since 1825. We compiled the complete history of these data from hardcopy sources, electronic data bases and recent files. The data show that there are now approximately 60 more days of open water per year (and 60 days less ice cover) than in the early 1800's. The net change is due to both a later freeze-up and earlier break-up. While significant changes can be attributed to the Mactaquac dam there is strong evidence that the duration of the ice season continues to decline.

1DPA1.15
Reducing our Vulnerability to Extreme Meteorological EventsAtmospheric Hazards in Atlantic Canada
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Economic or social disruptions due to extreme meteorological events occur with regular frequency in the Atlantic Provinces. In order to properly prepare for these events it is necessary to understand the probability of their occurrence. This risk is often difficult to quantify because the data and information are scattered and difficult to access or understand.

We compiled the probability of occurrence of significant atmospheric hazards in Atlantic Canada. The information was primarily derived from the National Archive of meteorological observations and supplemented with related material. The results are presented on a series of maps encompassing severe winter weather like blizzards, heavy snowstorms and ice storms to summer severe weather like heat waves, air quality, tornadoes and hurricanes. This information will be publicly available through a hazards website.

3C2.8
SPI-ing on Drought: Using the Standardized Precipitation Index to Identify and Rank Historical Droughts in Canada
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(Presented by / Présenté par ***W.G. Richards***)
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Drought is a hazard which is difficult to define, detect and measure. Drought (not aridity) affects all climates as it relates to some deviation from the normal moisture supply. To evaluate drought in Canada, which bridges several climate zones, one requires a universal index. We chose to use the Standardized Precipitation Index (SPI). We gridded monthly precipitation data for the Canadian provinces from 1900 to 2004 on a 0.2 by 0.2 degree grid and then applied an

established algorithm to calculate the 1, 2, 3, 6, 9, 12 and 24-month SPI at each grid point for the duration of the data set. The resulting SPI data permits identification of droughts by severity, area and duration.

Since 1950 the top three spring/summer droughts in Canada were 1961, 1958 and 1967. The drought of 2001 (which inspired this study) ranked 4th. The 2001 drought was unique in several ways:
(1) It affected the Prairies, Southern Ontario/Quebec and the Maritimes simultaneously,
(2) On the prairies it was the most severe since 1967 (34 years) and
(3) In Southern Ontario/Quebec it was the most severe since 1962 (40 years).

3C3.9
Modelling the Influence of ENSO Teleconnections at the LGM on the Laurentide Ice Sheet
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The effects of interannual atmosphere-ocean ENSO variability at the Last Glacial Maximum on the millennial scale dynamics of the Laurentide ice sheet are explored via a series of ice sheet simulations forced by AO-GCM output. The LGM ENSO signature from the AO-GCM is characterized by strong high latitude teleconnections that include modulations of the split jet stream structure with regional mass balance implications for the Laurentide ice sheet. Idealized ice sheet simulations driven by persistent El Nino (La Nina) climatological perturbations result in overall thinning (thickening) at the northwest margin of the Laurentide ice sheet on the order of 10\%, and vice versa at the southeastern margin. Ice sheet simulations forced by a combined El Nino + La Nina teleconnection climate perturbation are dominated by the stronger El Nino response and are sensitive to the seasonality of the LGM ENSO cycle.

3C4.1 **INVITED / INVITÉ**
THORPEX Societal and Economic Applications: Overview and Example
Jeffrey Lazo
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Societal and Economic Applications (SEA) research is one of the four key research threads of the THORPEX program. The SEA research objectives include: identify high-impact weather forecasts; assess the impact of improved forecast systems; develop advanced forecast verification measures; estimate net benefits of improved forecast systems; develop new user-specific weather products; and facilitate transfer of THORPEX advances to forecast centers throughout the world. I will first provide an overview of international and North American regional SEA efforts. I will then discuss our ongoing work to elicit household's values for potential improvements in daily weather forecasts – work funded by a NOAA THORPEX grant. The purpose for the study follows from the fact that weather forecasts are generally treated as public goods, markets have not developed for the provision of weather forecasts for the public, and thus there is no market information on households' values for forecasts. We are eliciting households' values using a non-market stated preference valuation approach. To date we surveyed 381 individuals in nine cities across the United States. Using a conjoint analysis approach focusing on forecast attributes, we found that people are willing to pay approximately $16 per household for a program that would significantly improve day-to-day weather forecasts. With 105 million households in the United States, the total value to society of improving day-to-day weather forecasts may exceed $1.5 billion. We will discuss efforts to date and current plans for revising the survey instrument and implementing using a national sample of US households.

1B4.1 **INVITED / INVITÉ**
IPY, the International Status

Michel Béland
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A short presentation will be given to describe the up to date status of the International Polar Year Program. More specifically, a short history of the program will be presented, leading up to the almost final scientific content of the program, following the conclusion of the three international calls for proposals in January 31st, 2006. A selection of some of the projects approved will be presented, stressing the Canadian involvement. The activities of the observation, data and education and outreach sub-committees will also be discussed.

4C2.6
How Density Currents Set the Vertical Stratification of Deep Oceanic Basins and LAkes
Mathew Wells
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Cooling or evaporation in marginal seas or shallow coastal embayments leads to the formation of dense water masses, which drain away in the form of density currents or underflows. In many cases the source water in the currents is initially denser than the bottom waters of the basin it flows into, but mixing dilutes the current so that it can intrude at mid-depth. Such small-scale mixing is difficult to parameterize in a large-scale numerical ocean models, but the depth at which deep waters spread has been shown to have important impacts on climate.

I will present recent experimental measurements of the entrainment rates in density currents. Using these results I will show how the small scale mixing of the density currents will set the depth at which a density current intrudes into a stable stratification, and how the upwelling driven by a density current in a confined basin can set the large scale density stratification.

4DPA7.5
Assessment of the Impact of Trans-Pacific Iron Transport on Oceanic CO2 Drawdown and DMS Production
Chi-Shing Wong
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Two important climate gases acts on the radiative balance of the lower atmosphere in opposite ways:CO2 will cause warming and DMS cooling. An iron fertilization experiment of SERIES was carried by C-SOLAS at Station P (50ºN, 145ºW) in 2002. The results show significant CO2 drawdown and production of DMS after iron addition. The CO2 drawdown in SERIES is an experimental verification of the glacial-interglacial CO2 change in Martin's Iron hypothesis. However, DMS was not factored in by Martin. New factors of DMS and trans-Pacific transport of iron aerosol from Gobi Desert and volcanic ash are examined and their impact on CO2 drawdown assessed.

Public / Publique.1 **INVITED / INVITÉ**
The Science (and Politics) of Global Warming
Andrew J. Weaver
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In February 2007 the United Nations Intergovernmental Panel on Climate Change (IPCC) will release its Fourth Assessment Report on climate change science. Six years will have elapsed since the IPCC released its Third Assessment Report containing the statement:

"There is now new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

The science leading up to this statement will be addressed along with subsequent advances in climate change science. A historical perspective on the Earth's climate over the last 400,000 years, and the science of global warming over the last 200 years will also be offered. Finally, a discussion of some outstanding uncertainties and a look towards the future will be presented.

3DPA2.5
Monitoring MIddle Atmospheric Chemistry at the Polar Environment Atmospheric Research Laboratory (PEARL)

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K. Strong[1], J.R. Drummond[1], A. Manson[2], C.T. McElroy[3], G. Shepherd[4], R. Sica[5], J. Sloan[6], K.A. Walker[6], W. Ward[7], J. Whiteway[4], T.G. Shepherd[1], J.C. McConnell[4], P.F. Bernath[6]

[1] University of Toronto
[2] University of Saskatchewan
[3] Environment Canada
[4] York University
[5] University of Western Ontario
[6] University of Waterloo
[7] University of New Brunswick

The recently established Polar Environment Atmospheric Research Laboratory (PEARL) is located in the Canadian high Arctic at Eureka, Nunavut (80°N). It is being equipped with a suite of instrumentation to investigate chemical and physical processes in the atmosphere from the ground to 100 km. One of four research themes being pursued at PEARL is that of Arctic Middle Atmosphere Chemistry, which is focussed on the question of "What is the composition of the Arctic atmosphere above the site and how is it changing with time?" The overall goal of this theme is to improve our understanding of the processes controlling the Arctic stratospheric ozone budget and its future evolution, using measurements of the concentrations of stratospheric constituents, in conjunction with dynamical, radiative, aerosol/PSC, and meteorological observations also made at PEARL. The complexity of the atmosphere and the different spectroscopic signatures of its many chemical constituents make it impossible to measure all relevant species using any one remote sounding technique. Rather, these measurements will be made using the complementary capabilities of several of the PEARL instruments, including an ozone lidar, a Fourier transform infrared spectrometer, a UV-visible grating spectrometer, and an Atmospheric Emitted Radiance Interferometer. This presentation will provide an overview of the Arctic Middle Atmosphere Chemistry theme, including its scientific motivation, objectives, and planned measurements and science activities.

1B1.4
The Earth Clouds Aerosol and Radiation Explorer (EarthCARE) mission.

David Donovan , EarthCARE Mission advisory group
Royal Netherlands Meteorological Institute
Contact:donovan@knmi.nl

The Earth Clouds Aerosol and Radiation mission (EarthCARE) is a joint mission involving ESA as well as (Japan Aerospace Exploration Agency) (JAXA) and the Japanese National Institute of Information and Communications Technology) Japan (NICT). EarthCARE is slated for launch in the 2011-2012 time period and will be the first mission to combine multiple active remote sensing instruments on a single platform specifically for cloud, aerosol and radiation studies. EarthCARE is focused on investigating the interactions between clouds, aerosol and long and short-wave

atmospheric radiation. The proposed platform includes an advanced lidar, a Doppler capable cloud profiling radar, a multispectral cloud/aerosol imager and long and short-wave broad-band radiometers. EarthCARE has been specifically designed with the scientific objectives of determining, in a radiatively consistent manner, the global distribution of vertical profiles of cloud and aerosol characteristics in order to better understand the role of clouds and aerosol in radiative transfer in the Earth's atmosphere. To achieve this goal, synergy between the active and passive instruments will be required. In this talk an overview of the EarthCARE mission will be given. As well some results of ongoing simulation studies will be briefly presented which highlight the powerful synergetic retrieval approaches that will be possible with EarthCARE.

References

Please see http://www.esa.int/esaLP/ASESMYNW9SC_LPearthcare_0.html

4DPA7.3
Internally-mixed Organics Increase Cloud Condensation Nuclei Number Concentrations over the North Pacific Ocean

Lisa Phinney [1], *Ulrike Lohmann* [2], *W. Richard Leaitch* [1], *Nicole C. Shantz* [1]
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Measurements of aerosol number concentration, size distribution, and chemical composition in the remote North Pacific Ocean in July 2002 indicate that, in general, sulphate and methanesulphonic acid (MSA) are internally-mixed in a mode centred at 500 nm vacuum aerodynamic diameter. Organics are also present in this mode, though slightly skewed to smaller sizes. An episode of higher organics concentration (~1.0 ug m^{-3}) provides evidence that MSA and sulphate are condensing onto small externally-mixed organic particles and growing by coagulation, incorporating sulphate, MSA, and aged organics into an internally-mixed mode. Concentrations of cloud condensation nuclei (CCN) are most significantly related to the mass of sulphate and MSA, but the presence of higher concentrations of organics in aerosols smaller than 100 nm is associated with an increased sensitivity of the CCN concentrations to sulphate and MSA mass, a result of the condensation of sulphate and MSA onto the smaller organic particles.

3DPA3.12
The Extratropical Transition of Tropical Storm Ophelia (2005): Summary of Forecasts and Meteorological Observations

Chris Fogarty
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During the 2005 Atlantic Hurricane season, Hurricane Ophelia skirted along the outer banks of North Carolina on 15 September and accelerated toward Nova Scotia while undergoing extratropical transition (ET). A shortwave trough moving eastward from the Great Lakes introduced significant vertical wind shear over the storm (up to 20 m s^{-1}) and very dry midlatitude air which tore apart the upper portion of the circulation (above 600 hPa) on 17 September. Ophelia became extratropical when it arrived at the coast of Nova Scotia as a 45-kt (23-m s^{-1}) storm bringing heavy rains and gusty southeasterly winds.

The NOAA Hurricane Research Division and the Meteorological Service of Canada conducted two observational research flights into Ophelia during its ET phase as part of the 2005 Intensity Forecasting Experiment (IFEX). The first flight took place on 16 September as Ophelia was beginning transition. The second flight was conducted on 17 September when the storm was becoming sheared apart by strong southwesterly winds aloft. Cross-sectional analyses of dropwindsonde data will be presented and compared with large scale synoptic weather analyses

and surface meteorological data.

Many forecast challenges were present during the ET of this event, primarily because of the oblique angle at which Ophelia was to approach the Nova Scotia coastline, and some uncertainty as to whether modest baroclinic intensification would occur as indicated by some numerical models. The Canadian GEM model appropriately forecast the shearing-apart and dry-air intrusion into the storm on 17 September, yet overpredicted the storm's intensity. Several weather warnings were posted by the Canadian Hurricane Centre and local weather office which did not materialize. There was a significant (overreaction) from the media which compounded the problem. This case not only highlights the existing numerical and operational forecast challenges associated with ET, but also the challenges of conveying warnings and forecast confidence to the public.

4DPA8.5
Hydraulic analysis of an under-ice river plume in coastal waters
S. S. Li , R. G. Ingram
(Presented by / Présenté par ***S. Samuel Li***)
Department of Earth and Ocean Sciences, University of B.C.
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This paper deals with an under-ice plume generated by the freshwater river discharge into saline coastal waters. The water surface is covered by landfast ice that moves little horizontally but undulates vertically with the tide. This motion causes variations, over a tidal cycle, in the effective cross-sectional area of the river mouth, through which freshwater flows, and hence causes variations in freshwater flow-rate for a given discharge. Our work was motivated by the 1988 and 1990 early spring observations of under-ice freshwater plumes of the Great Whale River on the southeast coast of Hudson Bay. These observations showed offshore isopycnal deepening, which may have important biological consequences. We investigate the behavior of an under-ice freshwater plume and potential mechanisms for plume deepening, using a hydraulic model. The model allows for an upper layer of freshwater flowing offshore above a lower layer of ocean water; the density interface between the two layers is assumed to be sharp and impermeable. The model takes into account friction on the bottom boundary and at the interface, as well as friction exerted by the ice cover on the flowing upper layer. The equations of continuity and momentum balance are solved, with dimensionless parameters related to topography, flow rate and density stratification. Using observations in Hudson Bay to estimate the parameters, we make comparisons between the model results and in-situ observations, which provides an interpretation of the observed Great Whale River plume characteristics.

.1 **INVITED / INVITÉ**
Women in Science and Technology - Panel Discussion
Ann Douglass [1] , Susan Woodbury [3] , Nancy Cutler [2]
(Presented by / Présenté par ***Anna Deptuch-Stapf***)
[1] National Aeronautics and Space Administration
[2] retired Director General of the Meteorological Service of Canada
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Traditionally, during the CMOS Congress, there is a luncheon to focus on women's issues in a professional environment. Men and women from all scientific professions are welcome to this year's Women In Science and Technology (WIST) meeting on Thursday, June 1, 2006 from 12:30 pm to 2:00 pm.

A panel discussion on professional careers in meteorology and oceanography will be the focus. The panelists are:

- Anne Douglass, an esteemed scientist from National Aeronautics and Space Administration (NASA);

- Susan Woodbury, President of CMOS and President of Woodbury Management Solutions and
- Nancy Cutler, retired Director General of the Meteorological Service of Canada (MSC).

We will learn from the contrasting experiences and stories of three women who represent careers in the private sector, the Canadian government and the NASA administration. Their professional experiences are distinctly different, but all strongly based on their love and devotion to science.

Please come to meet these three incredible women and draw inspiration from their unusual careers and stories. Our moderator, Ann McMillan of the MSC will be there to facilitate the session and to take your questions. Ann is the new World Meteorological Organization's (WMO) gender focal point for the MSC.

4DPA8.5
Hydraulic analysis of an under-ice river plume in coastal waters

S. S. Li , R. G. Ingram
(Presented by / Présenté par S. Samuel Li)
Department of Earth and Ocean Sciences, University of B. C.

Contact: ssli@civil.ubc.ca

This paper deals with an under-ice plume generated by the freshwater river discharge into saline coastal waters. The water surface is covered by landfast ice that moves little horizontally but undulates vertically with the tide. This motion causes variations, over a tidal cycle, in the effective cross-sectional area of the river mouth, through which freshwater flows, and hence causes variations in freshwater flow-rate for a given discharge. Our work was motivated by the 1988 and 1990 early spring observations of under-ice freshwater plumes of the Great Whale River on the southeast coast of Hudson Bay. These observations showed offshore isopycnal deepening, which may have important biological consequences. We investigate the behavior of an under-ice freshwater plume and potential mechanisms for plume deepening, using a hydraulic model. The model allows for an upper layer of freshwater flowing offshore above a lower layer of ocean water; the density interface between the two layers is assumed to be sharp and impermeable. The model takes into account friction on the bottom boundary and at the interface, as well as friction exerted by the ice cover on the flowing upper layer. The equations of continuity and momentum balance are solved, with dimensionless parameters related to topography, flow rate and density stratification. Using observations in Hudson Bay to estimate the parameters, we make comparisons between the model results and in-situ observations, which provides an interpretation of the observed Great Whale River plume characteristics.