NSERC CREATE
Training Program in Arctic Atmospheric Science

University of Toronto | Dalhousie University | University of New Brunswick | Université de Sherbrooke
York University | University of Waterloo | University of Western Ontario | University of Saskatchewan
Environment Canada | University of Idaho | University of Wisconsin | NOAA

2012 Summer School in Arctic Atmospheric Science

July 23-27, 2012 • Nottawasaga Inn • Alliston, Ontario, Canada

2012 Program

Funding provided by:

NSERC
CRSNG

NSERC CREATE Training Program in Arctic Atmospheric Science

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Program Coordinator:
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Program Website: http://www.candac.ca/create/

Program Description:

The NSERC CREATE Training Program in Arctic Atmospheric Science is a six-year project, begun in 2010 and supported by NSERC's Collaborative Research and Training Experience Program. Our Program aims to provide students and postdoctoral fellows with training in Arctic atmospheric science, including the use of state-of-the-art instrumentation and analysis of large data sets.

This Program takes advantage of the unique capabilities of the Polar Environment Atmospheric Research Laboratory (PEARL) located at Eureka, Nunavut in the High Arctic (80N, 86W). PEARL has been established by the Canadian Network for the Detection of Atmospheric Change (CANDAC), which is dedicated to addressing issues related to air quality, ozone and climate change. The PEARL facility is home to more than 25 instruments that are being used to make comprehensive measurements of the atmosphere from the ground to 100 km. It is also one of the observatories of the International Arctic Systems for Observing the Atmosphere (IASOA). The students supported under this CREATE Program benefit from the significant investment that Canada has made in PEARL; they have access to a world-class facility, unique data sets, and a large team of researchers with a breadth of expertise.

The Training Program includes formal and informal supervision, an Exchange Program, an Annual Summer School, an Annual Research Symposium, an Undergraduate Summer Internship Program, and an Industrial Partnership Program.

The ultimate goal of the Training Program is to significantly enhance the educational opportunities available to young researchers interested in polar, atmospheric, and climate sciences, enabling them to build collaborations and networks, and to develop scientific, technical, communications, and organizational skills. Such skills will make them excellent candidates for employment in academic, industrial, and government positions in environmental science and policy.

Summer School Speakers

Jean-Pierre Blanchet is a professor at the Center for Study and Simulation of Regional Climate and the Canadian Regional Climate Modeling and Diagnostics Network. He is currently leading the satellite project TICFIRE (Thin Ice Clouds in the Far IR Experiment) for the Canadian Space Agency. His speciality is physical climatology.

Florent Bouguin is an engineering supervisor for the ABB group, responsible for product development for analytical and remote sensing markets. He joined the ABB group in 2001 as a project engineer responsible for space product manufacturing and was later appointed product assurance manager. He has worked with the CSA, NASA and JAXA.

Tim Canty is an assistant research scientist in the Department of Atmospheric and Oceanic Science at the University of Maryland, College Park. He is a physicist who studies a wide range of topics including regional and local air quality, upper atmospheric ozone, and global climate change.

V. Lynn Harvey is a research scientist at the University of Colorado's Laboratory for Atmospheric and Space Physics. Her research combines satellite measurements, meteorological data, global climate modeling, and Lagrangian trajectory simulations to study the dynamics and transport of trace species in the Earth's middle atmosphere.

Brian Manning is the Director of Education Programs with Nunavut Arctic College. He is the recipient of Parks Canada's Ambassador for Education Award. He is a "Northern Educator" and a longtime advocate for outreach programs and supporter of CANDAC and ACE initiatives in the Territory of Nunavut.

Chris McLinden is a research scientist in the Air Quality Research Division at Environment Canada in Toronto. He is PI on a project aimed at monitoring air pollution from the oil sands using satellite remote sensing, and his main research interests are in remote sensing and radiative transfer.

Stella M. L. Melo is a research scientist at the Canadian Space Agency and is currently working as a Policy Analyst. She has been mission scientist of several CSA satellite missions and specialist on satellite data utilization for atmosphere and climate studies. Her research focus is solar variability and climate.

Margaret Munro is a senior writer at Postmedia News, which serves the Ottawa Citizen, Montreal Gazette, Vancouver Sun and other newspapers across Canada. She sits on the Editorial Advisory Committee of the Science Media Centre of Canada and the board of the Canadian Science Writers Association.

Martin Sharp is a professor and Chair in the Department of Earth and Atmospheric Sciences, University of Alberta, and Chair of the IASC Cryosphere Working Group. His research is focused on glacier/climate interactions in the Canadian Arctic, and on biogeochemical process in glacial systems.

Paul Sullivan is the Antarctic Support Contract's Area Science and Technical Project Support Manager - Amundsen Scott South Pole Station. He is an expert in planning and implementing construction projects in Antarctica. As manager, he ensures the operations and maintenance of science and infrastructure at the South Pole Station.

Christian Zdanowicz is a glaciologist with the Geological Survey of Canada in Ottawa. For the past 20 years, he has conducted field research on climate and atmospheric change in the Canadian Arctic and subarctic. He currently studies the response of glaciers to climate warming on Baffin Island.

CREATE Speakers

Kimberly Strong is a professor in the Department of Physics at the University of Toronto. Her research involves atmospheric remote sounding using ground-based, balloon-borne, and satellite instruments for studies of stratospheric ozone chemistry, climate, and air quality. She runs four instruments at PEARL and is the CREATE Training Program Director.

Ashley Kilgour is the CREATE Training Program Coordinator and the Education and Outreach Facilitator for CANDAC. She informs and interacts with students, teachers and community members in both Northern and Southern Canada. She also develops educational materials for teachers and students aimed at enhancing environmental science education.

James Drummond is a professor at Dalhousie University. He is a Fellow of the Royal Society of Canada, and holds a Canada Research Chair in remote sounding of atmospheres. He is PI of the MOPITT satellite experiment, Co-I on the ACE mission, and PI for CANDAC and PEARL.

Emily McCullough is a PhD student at the University of Western Ontario, studying lidar measurements of clouds in the Arctic. She is Chair of the CREATE Trainees' Advisory Committee and the Trainees' Representative on the Training Program Committee.

Dan Weaver is a MSc student at the University of Toronto, comparing atmospheric water vapour measurements at Eureka. He is a member of the CREATE Trainees' Advisory Committee and its Social Media Coordinator.

Summer School Students

	Name	Institution (home/summer)
1	Christian Akpanya (MSc)	University of New Brunswick
2	Peter Argall (CREATE intern)	University of Western Ontario
3	Justin Bandoro (NSERC USRA intern)	University of Western Ontario
4	Alexandre Bevington (BSc)	University of Ottawa
5	Yacine Bouzid (PhD)	Université de Quebec à Montréal
6	Tyler de Jong (MSc)	University of Ottawa
7	Ryan De Vries (CREATE intern)	University of Western Ontario
8	Jonathan Franklin (PhD)	Dalhousie University
9	Debora Griffin (PhD)	University of Toronto
10	Chieh-Ting (Jimmy) Hsu (CREATE intern)	Dalhousie University/University of Waterloo
11	Liviu Ivanescu (PhD)	Université de Sherbrooke
12	Stefan Keiderling (MSc)	University of Bergen (Norway)
13	Felicia Kolonjari (PhD)	University of Toronto
14	Philippa Krahn (CGCS intern)	Queen's University/University of Toronto
15	Samuel Kristoffersen (PhD)	University of New Brunswick
16	Erik Lutsch (CREATE intern)	University of Waterloo
17	Zen Mariani (PhD)	University of Toronto
18	Michael Maurice (City of Barrie intern)	Georgian College
19	Miriam Richer McCallum (BSc)	Carleton University
20	Emily McCullough (PhD)	University of Western Ontario
21	Steven McLaughlin (CREATE intern)	Dalhousie University/University of New Brunswick
22	Joseph Mendonca (PhD)	University of Toronto
23	Boris Pavlovic (CGCS intern)	University of Guelph/University of Toronto
24	Chris Perro (PhD)	Dalhousie University
25	Keven Roy (PhD)	University of Toronto
26	Niall Ryan (PhD)	University of Toronto
27	Mark Semelhago (CREATE intern)	University of Toronto
28	Nicole Schaffer (PhD)	University of Ottawa
29	Patrick Sheese (PDF)	University of Toronto
30	Alessio Spassiani (CREATE intern)	York University/University of Toronto
31	Wenxia Tan (PhD)	University of Waterloo
32	Christopher Vail (BSc and BCS)	University of New Brunswick
33	Dan Weaver (MSc)	University of Toronto
34	Robin Wing (MSc)	University of Western Ontario
35	Mitchell Wolf (CREATE intern)	University of Victoria/University of New Brunswick
36	Xiaoyi Zhao (PhD)	University of Toronto
37	Shouming Zhou (PDF)	University of Toronto
38	Johannes Zielcke (PhD)	University of Heidelberg (Germany)

CANDAC

Canadian Network for the Detection of Atmospheric Change

www.candac.ca

The Canadian Network for the Detection of Atmospheric Change (CANDAC) is a network of university and government researchers dedicated to studying the changing atmosphere over Canada. CANDAC recognizes that two resources are critical for this effort: *physical facilities* which are used to perform research, and *highly skilled people* who conduct the research.

The CANDAC objectives are:

- Understanding atmospheric change over Canada
- Integration of measurements taken from space, aircraft, balloons and the ground
- Provision of quality-controlled research datasets to researchers
- Linkage with international networks for data exchange and supranational planning
- Maintenance of research-critical resources
- Training of skilled personnel
- Public Education

Since Canada has a significant portion of its territory in the Arctic, CANDAC has a particular emphasis on the Arctic. Recognizing that there is a lack of measurements recorded in the Arctic, and that the difficulties of making measurements there are very real, the first task of CANDAC has been to rejuvenate and operate the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut. This activity was accelerated by a desire to be ready for International Polar Year in 2007-2008 in order to participate in the world-wide effort to intensively study the Arctic region.

CANDAC/PEARL research is conducted within four major themes:

- Arctic Tropospheric Transport and Air Quality
  - How is air quality in the Arctic influenced by southern activities and vice-versa?
- Radiative Forcing
  - How do changes in the surface and atmosphere lead to heating and cooling?
- Middle Atmosphere Chemistry
  - How is the ozone layer changing?
- Waves and Coupling Processes
  - How do the various regions of the atmosphere interact?

In addition, CANDAC undertakes measurements at PEARL simultaneously with several satellite instruments. These "validation" measurements are extremely effective because of the location of PEARL, and they further enhance the science return of the research effort.

In the future, CANDAC is aiming to bring together many elements of the Canadian effort in research-level atmospheric measurements. These include the integration of space-based measurements with aircraft, balloon and ground-based measurements and the development of quality control protocols for these data. It is also hoped to set up a small number of "anchor sites" in Canada to conduct research in different regions and to provide further research opportunities to Canadians.

The Polar Environment Atmospheric Research Laboratory (PEARL) is found on the northern part of Ellesmere Island, in the vicinity of the Environment Canada Weather Station at Eureka, Nunavut. PEARL is composed of a number of interlinked observation sites. The major site is the PEARL Ridge Lab, which was formerly Environment Canada's Arctic Stratospheric Ozone Observatory (AStrO), located at 80°N, 86°W, 610 m altitude. The building was constructed by Environment Canada in 1992, specifically to study stratospheric ozone. It is some 15 km by road from Eureka and about 1,100 km from the North Pole.

The Zero Altitude PEARL Auxiliary Laboratory (ØPAL) is located at sea level at the outer perimeter of the Weather Station proper, and was added to expand the range of scientific research into the very lowest layers of the atmosphere. A third facility, the Surface and Atmospheric Flux, Irradiance and Radiation Extension (SAFIRE) is located remote from all structures, for measurements of the undisturbed terrain about 5 km from the Weather Station.

Operating research grade instrumentation in this remote environment thousands of kilometers from typical support structures is much like operating from a satellite, albeit on the ground. The challenge is to develop and implement instrument systems that will provide state of the art measurement capabilities with little hands-on intervention.

While at PEARL, CANDAC personnel and visiting scientists are housed at the Eureka Weather Station. The station is also an important link in the support chain for PEARL. CANDAC relies upon the skills, abilities, and hard work of the station staff for housing, meals, power and transportation. The Weather Station also handles tasks such as aircraft handling and plowing of the roads to the sites. The station contributes scientific value as well through their measurement program, especially the radiosonde and ozonesonde flights.

In April 2012, PEARL formally ended full-time year-round operations due to funding constraints. Since then, automated instruments continue to run with remote access, while those requiring manual intervention are being run on a campaign basis as funding allows, as CANDAC no longer has an operator on site. Efforts are underway to find new sources of funding to keep the PEARL facility open.

Our thanks to the following for their support of CANDAC and PEARL:

Environment Canada / Environnement Canada

Canada Foundation for Innovation / Fondation canadienne pour l'innovation

NSERC / CRSNG

Ontario Innovation Trust

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) / Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

Ontario Ministry of Research & Innovation

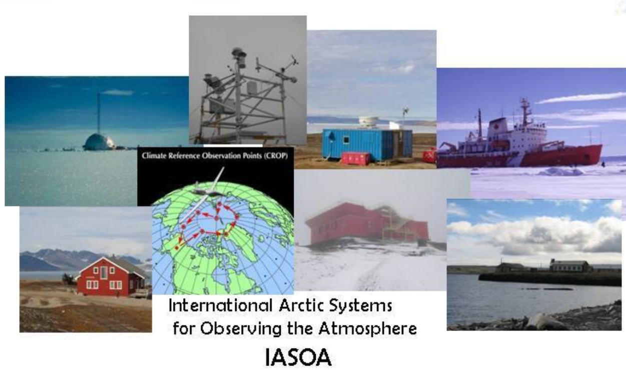
NSRIT – Nova Scotia Research and Innovation Trust

Northern Scientific Training Program

CSA ASC

Polar Continental Shelf Project (PCSP)

NOAA – National Oceanic and Atmospheric Administration, U.S. Department of Commerce



International Polar Year 2007-2008

Summer School Agenda

<u>Monday July 23, 2012</u>

Lectures will be held in room 10 and posters will be on display in room 10A on the ground floor.
Poster boards will be set up on Monday morning and posters can be hung in room 10A any time after arrival.
Please refer to page 21 for poster room layout, including individual poster locations.
Each day, two new science outreach demonstrations will be on display in room 10A.
The Welcoming Icebreaker begins at 8:30 PM at field 10 (see page 19 for map) and continues at ~9:30 PM at the lower patio (see page 20 for map).

Time		**Speaker/Organizer**	**Topic**
10:00 – ~11:30	Chartered bus departs Holiday Inn (280 Bloor Street West, Toronto, ON) for the Nottawasaga Inn. Please be there and ready to leave promptly at 10:00 AM.		
11:30 – 12:00	Arrival and check-in at Nottawasaga Inn (6015 Highway 89, Alliston, ON)		
12:00 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 2:15	Welcoming remarks	Kim Strong	Introduction to the CREATE Training Program in Arctic Atmospheric Science and CANDAC/PEARL
		Emily McCullough	Overview of the CREATE Trainees Advisory Committee (TAC)
		Dan Weaver	Overview of the Career Panel
		Ashley Kilgour	Introduction to education and outreach demonstrations
2:15 – 3:45	Jamboree	All attendees	Student and speaker research jamboree (two minutes and one slide per attendee)
3:45 – 4:15	Coffee break (room 10A)		
4:15 – 5:00	Lecture A	Brian Manning	Nunavut: Tracks in the snow - an overview of the cultural dynamic, history, and institutions of Nunavut
5:00 – 5:45	Lecture B	Martin Sharp	Ice-climate interactions
5:45 – 6:30	Lecture C	Jean-Pierre Blanchet	Aerosol and greenhouse gas forcing on the Arctic climate
6:30 – 7:00	Free time (except for poster judges – they will meet at 6:30 in room 10 for a short discussion)		
7:00	Dinner (Riverview Dining Room)		
8:30	Welcoming Icebreaker	All attendees	Field 10 at 8:30 and lower patio at ~9:30 Sponsored by ABB Inc.

Tuesday July 24, 2012

Lectures will be held in room 10 and posters will be on display in room 10A on the ground floor.
Please stay near your poster for your assigned presentation times, as judges will be evaluating your poster during this time (see page 21 for details).
Note that awards will be given to the best posters on Thursday evening after the Career Panel.
Outdoor recreational activities will begin at 8:30 PM at field 10 (see page 19 for map).

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Chris McLinden	Radiative transfer modeling of the atmosphere
9:45 – 10:30	Lecture B	Paul Sullivan	Antarctic logistics: How do you get people and materials to the South Pole?
10:30 – 11:00	Coffee break (room 10A)		
11:00 – 12:30	Posters	All attendees	Student poster session Judges (MSc, PhD and PDF posters): Jean-Pierre Blanchet, Tim Canty, Lynn Harvey, Chris McLinden Judges (Undergraduate posters): Zen Mariani, Nicole Schaffer, Patrick Sheese, Shouming Zhou
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture C	Tim Canty	Understanding halogens in the Arctic
3:45 – 4:30	Lecture D	Lynn Harvey	Middle atmosphere dynamics: The polar vortices, anticyclones, and the stratopause atmospheric dynamics
4:30 – 5:00	Coffee break (room 10A)		
5:00 – 5:45	Lecture E	Martin Sharp	Glacier change in the Canadian Arctic
5:45 – 6:30	Lecture F	Brian Manning	Inuit Qaujimajatuqangit: Inuit societal values
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30	Free time & optional outdoor recreational activity	All attendees	Field 10 at 8:30 for outdoor sports (soccer, volleyball, ultimate frisbee)

Wednesday July 25, 2012

Lectures will be held in room 10 and posters will be on display in room 10A on the ground floor.
Please bring your laptop computers to the atmospheric photochemical modelling workshop beginning at 5 PM in room 10.
The education and outreach workshop will begin at 8:30 PM in room 10.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Jean-Pierre Blanchet	Polar clouds and moist process in climate change with implications for the mid-latitudes
9:45 – 10:30	Lecture B	Lynn Harvey	Using meteorological, satellite, and ground-based data to study the Arctic
10:30 – 11:00	Coffee break (room 10A)		
11:00 – 11:45	Lecture C	Christian Zdanowicz	Ice-core studies of atmosphere-cryosphere interactions
11:45 – 12:30	Lecture D	Tim Canty	Polar stratospheric ozone
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture E	Martin Sharp	Biogeochemical feedbacks between glaciers, the carbon cycle and the climate system
3:45 – 4:30	Lecture F	Brian Manning	Education in Nunavut: A southern perspective
4:30 – 5:00	Coffee break (room 10A)		
5:00 – 6:30	Workshop	Chris McLinden	Atmospheric photochemical modelling: introduction and hands-on exercise using a simple "two-box" model
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30 - 9:30	Workshop	Ashley Kilgour	Education and outreach
9:30	Free time		

Thursday July 26, 2012

Lectures will be held in room 10 and posters will be on display in room 10A on the ground floor.
Indoor recreational activities will take place in the Sports and Leisure Dome (see page 19 for map) beginning at 8:30 PM.
The CREATE Trainees' Advisory Committee (TAC) meeting will take place in the Riverview Dining Room during lunch. The TAC is currently looking for a few new recruits, so please join them for lunch at 12:30 PM if you are interested.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Jean-Pierre Blanchet	Monitoring aerosol, clouds and water in the polar atmosphere
9:45 – 10:30	Lecture B	Lynn Harvey	Atmospheric effects of energetic particle precipitation
10:30 – 11:00	Coffee break (room 10A)		
11:00 – 11:30	Lecture C	Stella Melo	Overview of space and climate within an operational context
11:30 - 12:30	Lecture D	Margaret Munro	Science journalism: what makes a good science story, where stories come from, tips on how to make the most of one's 15 minutes of fame (or, in the age of internet news, 15 seconds) and the importance of communicating with the public
12:30 – 1:30	Lunch (Riverview Dining Room)	CREATE Trainees' Advisory Committee meeting*	
1:30 – 3:00	Free time (except for poster judges – they will meet at 1:30 in room 10A to decide on poster awards)		
3:00 – 3:45	Lecture E	Paul Sullivan	From installation to maintenance of science facilities on the Antarctic polar plateau
3:45 – 4:30	Lecture F	Florent Bouguin	Next generation for atmospheric sensing technologies
4:30 – 5:00	Coffee break (room 10A)		
5:00 – 6:30	Career panel	Dan Weaver and all attendees	Panelists: Florent Bouguin (industry), Stella Melo (government), Margaret Munro (media), Martin Sharp (academia), Paul Sullivan (science support), and Brian Manning (northern issues)
6:30 – 7:00	Poster awards	Poster judges	The poster awards will be announced
7:00	Dinner (Riverview Dining Room)		
8:30	Free time & optional indoor recreational activity	All attendees	Indoor mini-putt (shotgun start begins at 8:30) followed by billiards, ping-pong, and arcade games

***CREATE Trainees' Advisory Committee Members:** David Daou, Jonathan Franklin, Felicia Kolonjari, Zen Mariani (Secretary), Emily McCullough (Chair), Chris Perro, and Dan Weaver (Social Media Coordinator)

Friday July 27, 2012

Lectures will be held in room 10 and posters will be on display in room 10A on the ground floor.
Your poster must be removed before lunch on Friday.
Please check out by 11 AM; you may want to check out in the morning before lectures begin at 9 AM.
A storage room beside room 10 will store your luggage until departure.

Time		**Speaker/Organizer**	**Topic**
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Chris McLinden	Satellite remote sensing of pollution with application to the Arctic
9:45 – 10:30	Lecture B	Tim Canty	Global climate and the Arctic
10:30 – 11:00	Coffee break (room 10A)		
11:00 – 12:00	Summer School Survey	CREATE Trainees' Advisory Committee	Summer school survey and Trainees' Advisory Committee presentation
12:00 – 1:00	Lunch (Riverview Dining Room)		
1:30 – 3:00	Depart Nottawasaga Inn for Toronto. Please be ready to leave at 1:30 PM – meet in the front lobby.		
~3:00	Arrive at the Holiday Inn (280 Bloor Street West)		

Jamboree

Requests

The slides are in alphabetical order by last name beginning with speakers followed by students. Please refer below to find your presentation slot and be prepared to begin when the person before you finishes.
You will be given two minutes to introduce yourself and your research. Please be courteous to the next speaker and wrap-up promptly when the bell rings. Please excuse any formatting errors that may have occurred in compiling the slides into one presentation.

Organizers

1. Kimberly Strong (CREATE Training Program Director)
2. Ashley Kilgour (CREATE Training Program Coordinator)

Speakers

3. Jean-Pierre Blanchet (Université de Quebec à Montréal)
4. Tim Canty (University of Maryland, College Park)
5. Lynn Harvey (University of Colorado)
6. Brian Manning (Nunavut Arctic College)
7. Chris McLinden (Environment Canada)
8. Martin Sharp (University of Alberta)
9. Paul Sullivan (Raytheon Polar Services)
10. Christian Zdanowicz (Geological Survey of Canada)

Kim Strong will introduce absent speakers:

11. Florent Bouguin (ABB Inc.)
12. James R. Drummond (Dalhousie University)
13. Stella Melo (Canadian Space Agency)
14. Margaret Munro (Postmedia News)

Students

1. Christian Akpanya (MSc)
2. Peter Argall (CREATE intern)
3. Justin Bandoro (NSERC USRA intern)
4. Alexandre Bevington (BSc)
5. Yacine Bouzid (PhD)
6. Tyler de Jong (MSc)
7. Ryan De Vries (CREATE intern)
8. Jonathan Franklin (PhD)
9. Debora Griffin (PhD)
10. Chieh-Ting (Jimmy) Hsu (CREATE intern)
11. Liviu Ivanescu (PhD)
12. Stefan Keiderling (MSc)
13. Felicia Kolonjari (PhD)
14. Philippa Krahn (CGCS intern)
15. Samuel Kristoffersen (PhD)
16. Erik Lutsch (CREATE intern)
17. Zen Mariani (PhD)
18. Michael Maurice (City of Barrie intern)
19. Miriam Richer McCallum (BSc)
20. Emily McCullough (PhD)
21. Steven McLaughlin (CREATE intern)
22. Joseph Mendonca (PhD)
23. Boris Pavlovic (CGCS intern)
24. Chris Perro (PhD)
25. Keven Roy (PhD)
26. Niall Ryan (PhD)
27. Nicole Schaffer (PhD)
28. Mark Semelhago (CREATE intern)
29. Patrick Sheese (PDF)
30. Alessio Spassiani (CREATE intern)
31. Wenxia Tan (PhD)
32. Christopher Vail (BSc)
33. Dan Weaver (MSc)
34. Robin Wing (MSc)
35. Mitchell Wolf (CREATE intern)
36. Xiaoyi Zhao (PhD)
37. Shouming Zhou (PDF)
38. Johannes Zielcke (PhD)

Welcoming Icebreaker

2012 NSERC CREATE Summer School in Arctic Atmospheric Science

Welcoming "Icebreaker"

Thank-you to our sponsor for this event

ABB

Field 10 at 8:30 PM
Lower patio at 9:30 PM
Nottawasaga Inn, Alliston, Ontario
July 23, 2012

http://www.abb.ca/

Career Panel

The Career Panel will take place on Thursday, July 26 from 5:00 – 6:30 PM and will be moderated by Dan Weaver, CREATE Trainees' Advisory Committee member and Social Media Coordinator.

This event provides an opportunity for CREATE Summer School attendees to gain valuable insight into future career paths. This diverse panel of successful science professionals represent the breadth of job opportunities available to science graduates. The session will begin with a five-minute introduction by each panelist, and proceed into an hour-long question and answer session.

Students are encouraged to think about their professional goals and anticipated career paths, and what questions they might ask during the Career Panel session to help inform or inspire their future job seeking efforts. The Trainee's Advisory Committee will provide a question-submission box (in room 10A) to enable students to anonymously submit their questions in writing ahead of time. The panel (or specific panelist) will be asked these questions during the session by the moderator.

Panelists

Florent Bouguin
(industry)
Engineering supervisor for the ABB group

Brian Manning
(education)
Director of Education Programs with Nunavut Arctic College

Stella M. L. Melo
(government)
Research scientist at the Canadian Space Agency

Margaret Munro
(media)
Senior writer at Postmedia News

Martin Sharp
(academia)
Professor and Chair in the Department of Earth and Atmospheric Sciences, University of Alberta, and Chair of the IASC Cryosphere Working Group

Paul Sullivan
(science support)
Antarctic Support Contract's Area Science and Technical Project Support Manager - Amundsen Scott South Pole Station

Suggested Readings and Websites

Jean-Pierre Blanchet:
http://scta.uqam.ca/personnel/25-jean-pierre-blanchet-phd.html

Florent Bouguin:
http://www.abb.ca/

Tim Canty:
http://www.atmos.umd.edu/~tcanty/

Lynn Harvey:
http://paos.colorado.edu/index.php?option=com_qcontacts&view=contact&id=42%3Aharvey-lynn-&catid=17%3Aresearchers&Itemid=139
Suggested readings:

- Middle Atmosphere Dynamics by Andrews, Holton and Leovy, Academic Press 1987 (http://store.elsevier.com/Middle-Atmosphere-Dynamics/David-Andrews/isbn-9780120585762/ and http://books.google.ca/books/about/Middle_Atmosphere_Dynamics.html?id=N1oNurYZefAC&redir_esc=y)
- Aeronomy of the Middle Atmosphere (3rd edition) by Brasseur and Solomon, Springer 2005 (http://www.springer.com/environment/pollution+and+remediation/book/978-1-4020-3284-4 and http://books.google.ca/books/about/Aeronomy_of_the_Middle_Atmosphere.html?id=HoV1VNFJwVwC&redir_esc=y)

Ashley Kilgour:
http://candac.ca/candac/Outreach/CANDACcollaboration/
http://apecs.is/outreach/
Suggested reading:

- Polar Science and Global Climate: An International Resource for Education and Outreach by Kaiser, Pearson 2010. (http://www.ipy.org/hidden/item/2297-promotional-material-for-the-polar-resource-book)

Brian Manning:
http://www.nac.nu.ca/

Stella Melo:
http://www.asc-csa.gc.ca/

Chris McLinden:
http://www.ec.gc.ca/

Margaret Munro:
http://margaretmunro.wordpress.com/
@margaretmunro (https://twitter.com/margaretmunro)

Martin Sharp:
http://arctic.eas.ualberta.ca/contact.html
Suggested reading:

- Chapter 7: Mountain Glaciers and Ice Cap (from *Snow, Water, Ice and Permafrost in the Arctic* (SWIPA) assessment, 2011 (http://www.candac.ca/create/ss2012/SWIPA2011_Sci_C07.pdf or see http://amap.no/swipa/)

Kimberly Strong:
http://www.atmosp.physics.utoronto.ca/people/strong/strong.html

Paul Sullivan:
www.usap.gov

CREATE/CANDAC:
http://www.candac.ca/create/
http://www.candac.ca/candac/
@CREATEArcticSci (https://twitter.com/CREATEArcticSci)
/CANDAC (http://www.facebook.com/groups/CANDAC/)

Nottawasaga Inn Facilities

Complimentary with Accommodations

25 metre indoor swimming pool
100ft waterslide
Squash & racquetball courts
Fully-equipped fitness centre
Sauna & Whirlpool
(Available during scheduled times. Age and ability restrictions may apply)

Seasonal

Outdoor swimming pool
Bocce
Volleyball
Horseshoes
Nature/jogging trail

Pay-As-You-Play Activities

45 holes of golf on 2 courses
Private golf lessons (CPGA certified instructors)
(Call main pro shop for rates & tee-off times - (705) 435-5504)

Centre Ice Arena
2 NHL-size ice surfaces

Jungle Quest
Indoor 18 hole miniature golf
($5. per person)

Games Room
Video arcade and billiards tables

Tennis
3 indoor courts
(call the Sports & LeisureDome for rates & availability - (705) 435-5502)

Aerobics, Aquafit, Fitness Classes, Swim Lessons
(call the Sports & LeisureDome for rates & availability - (705) 435-5502)

Massage Therapy
(rates starting at $45. Call the Sports & LeisureDome - (705) 435-5502)

Esthetician - (705) 435-8829

Hair Salon - (705) 435-4570

Starlite Lounge

Located on the 3rd floor, east wing
Monday to Saturday: 3pm - 12am
Sunday: 4pm - 11pm

Sports & LeisureDome

Hours of Operation

Monday to Thursday
Facility: 6:30am - 10:00pm
Fitness Club: 6:30am - 9:30pm
Pool & Sauna: 7:00am - 9:30pm
Waterslide: 8:00pm - 9:00pm

Friday
Facility: 6:30am - 11:00pm
Fitness Club: 6:30am - 10:30pm
Pool & Sauna: 7:00am - 10:00pm
Waterslide: 5:00pm - 9:30pm

Saturday
Facility: 8:00am - 11:00pm
Fitness Club, Pool, Sauna: 8:00am - 10:00pm
Waterslide: 10:00am - 12:00pm, 1:00pm - 5:00pm, 8:00pm - 9:00pm

Sunday
Facility: 9:00am - 9:00pm
Fitness Club, Pool, Sauna: 9:00am - 8:00pm
Waterslide: 10:00am - 12:00pm, 6:30pm - 8:00pm
(Hours of operation may change seasonally)

Riverview Dining Room

Breakfast Buffet: 7:00am - 10:00am
Lunch Buffet: 11:30am - 1:30pm
Sunday Brunch: 10:30am - 1:30pm

Dinner (Table d'hôte)
Monday - Thursday: 6:00pm - 9:00pm
Friday & Saturday: 5:30 - 9:30pm
Sunday: - 5:30pm - 9:00pm
(A buffet dinner may be substituted for menu options during certain holiday periods)

Mahogany Room

Monday - Thursday: 6:00pm - 9:00pm
Friday & Saturday: 5:30 - 9:30pm
Closed Sundays & Holidays
(Smart-casual dress code in effect for Mahogany Room)

Inn Café

Monday - Thursday: 10:00pm - 10:00pm
Friday & Saturday: 10:00am - 11:00pm
Sunday: - 9:00pm - 10:00pm

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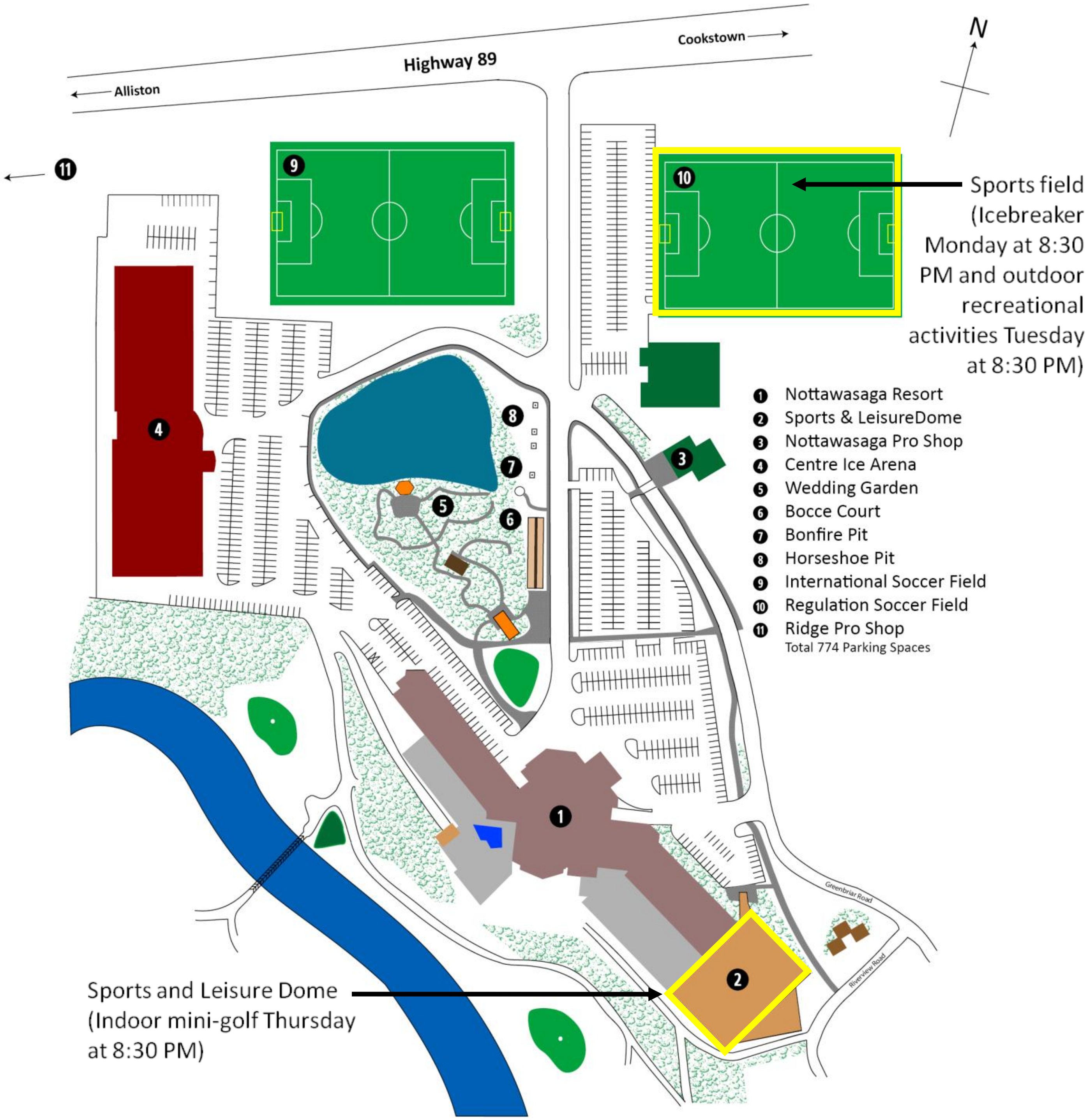
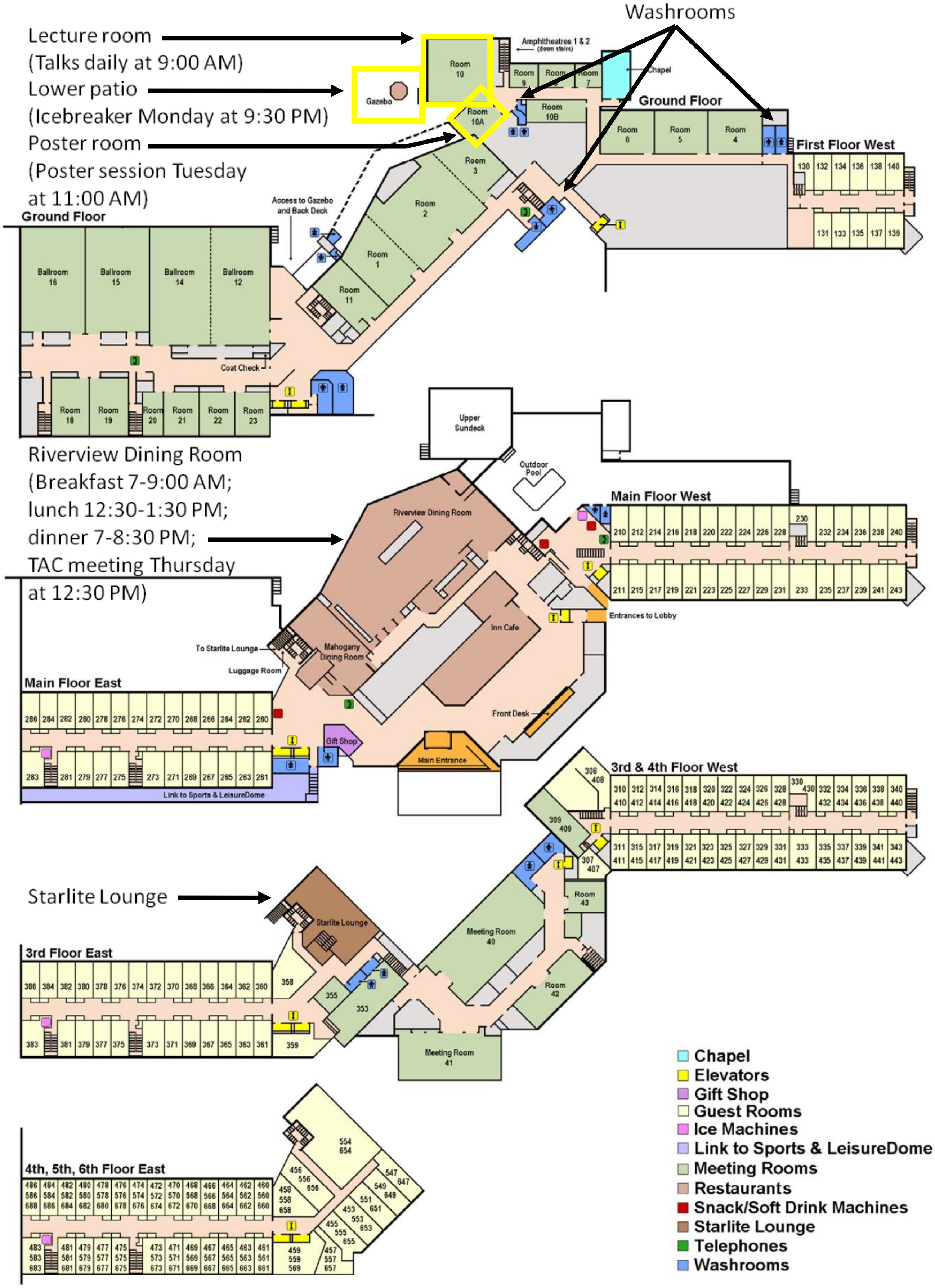
20110315

Nottawasaga Maps




Lecture room
(Talks daily at 9:00 AM)
Lower patio
(Icebreaker Monday at 9:30 PM)
Poster room
(Poster session Tuesday at 11:00 AM)
Washrooms
Riverview Dining Room
(Breakfast 7-9:00 AM;
lunch 12:30-1:30 PM;
dinner 7-8:30 PM;
TAC meeting Thursday at 12:30 PM)
Starlite Lounge
Ground Floor
First Floor West
Main Floor West
Main Floor East
3rd & 4th Floor West
3rd Floor East
4th, 5th, 6th Floor East
Amphitheatres 1 & 2 (down stairs)
Chapel
Gazebo
Access to Gazebo and Back Deck
Coat Check
Upper Sundeck
Outdoor Pool
Riverview Dining Room
Mahogany Dining Room
Inn Cafe
Front Desk
Main Entrance
Gift Shop
To Starlite Lounge
Luggage Room
Entrances to Lobby
Link to Sports & LeisureDome
Meeting Room 40
Meeting Room 41
Chapel
Elevators
Gift Shop
Guest Rooms
Ice Machines
Link to Sports & LeisureDome
Meeting Rooms
Restaurants
Snack/Soft Drink Machines
Starlite Lounge
Telephones
Washrooms

Poster Session

Posters will be displayed in room 10A from Monday through Friday. Poster boards will be set up on Monday morning. Please mount your posters in the locations indicated below sometime on Monday. Please stay near your poster for your assigned session on Tuesday, as judges will be visiting during your assigned session. Note that awards will be given to the best posters during the awards ceremony on Thursday afternoon, immediately after the Career Panel. Please take down your poster before lunch on Friday.

Judges for MSc, PhD and PDF posters
Jean-Pierre Blanchet
Tim Canty
Lynn Harvey
Chris McLinden

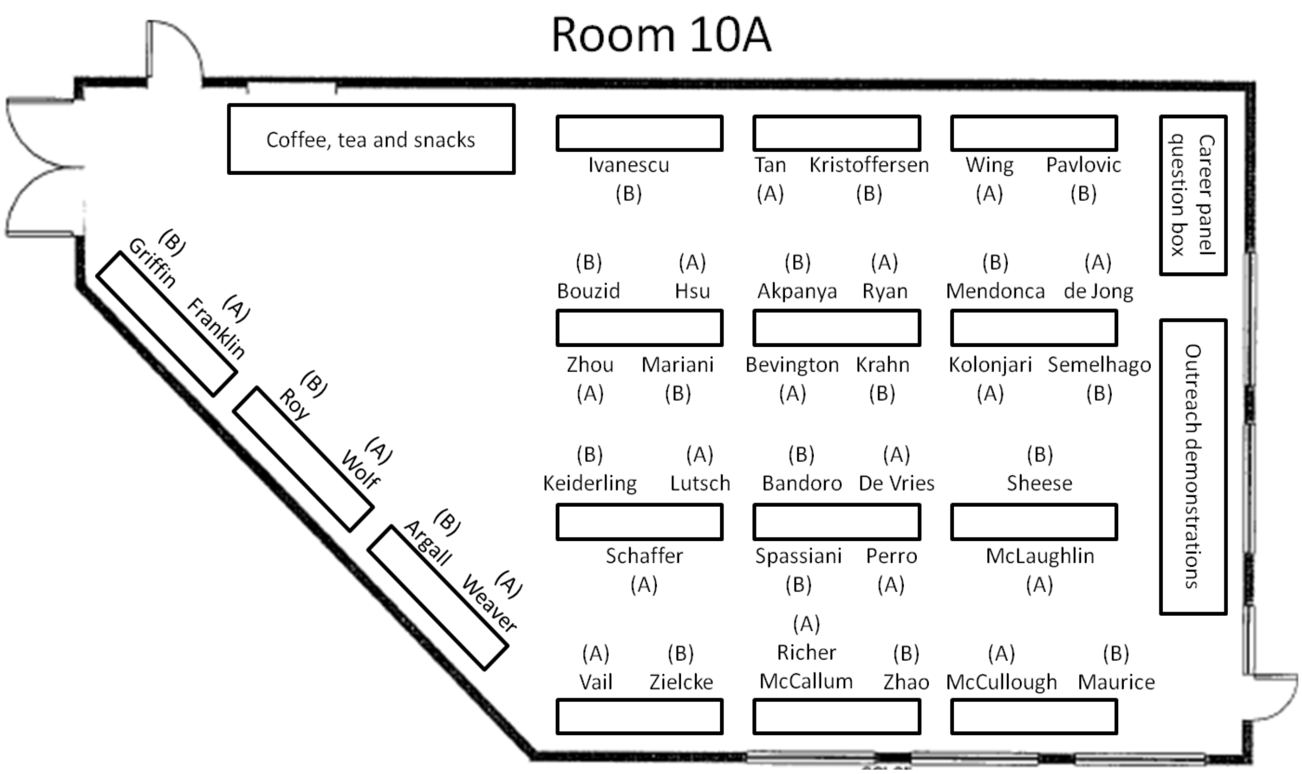
Judges for undergraduate posters
Session A: Zen Mariani and Patrick Sheese
Session B: Nicole Schaffer and Shouming Zhou

Session A (11:00 – 11:45 AM):

MSc/PhD/PDFs	Undergraduates
Tyler de Jong (Msc)	Alexandre Bevington (BSc)
Jonathan Franklin (PhD)	Ryan De Vries (BSc)
Felicia Kolonjari (PhD)	Jimmy Hsu (BSc)
Emily McCullough (PhD)	Erik Lutsch (BSc)
Chris Perro (PhD)	Miriam Richer McCallum (BSc)
Niall Ryan (PhD)	Steven McLaughlin (BSc)
Nicole Schaffer (PhD)	Christopher Vail (BSc)
Wenxia Tan (PhD)	Mitchell Wolf (BSc)
Dan Weaver (MSc)	
Robin Wing (MSc)	
Shouming Zhou (PDF)	

Session B (11:45 – 12:30 PM):

MSc/PhD/PDFs	Undergraduates
Christian Akpanya (MSc)	Peter Argall (BSc)
Yacine Bouzid (PhD)	Justin Bandoro (BSc)
Debora Griffin (PhD)	Philippa Krahn (BSc)
Liviu Ivanescu (PhD)	Mike Maurice (BA/college)
Stefan Keiderling (MSc)	Boris Pavlovic (BSc)
Samuel Kristoffersen (PhD)	Mark Semelhago (BSc)
Zen Mariani (PhD)	Alessio Spassiani (BSc)
Joseph Mendonca (PhD)	
Keven Roy (PhD)	
Patrick Sheese (PDF)	
Xiaoyi Zhao (PhD)	
Johannes Zielcke (PhD)	



POSTER ABSTRACTS

Comparison of gravity wave signatures in the E-Region Wind Interferometer (ERWIN) and PEARL All Sky Imager (PASI)

Christian Akpanya[1], W. Ward[1], S. Kristofferson[1], and T. Xie[1]

[1]Department of Physics, University of New Brunswick, Fredericton, Canada

Pronounced and extensive gravity wave signatures have been identified in the intensity images from the OH airglow all sky imager of January 26 2009 between the hours of 07:30 to 13:00 UTC. Similar signals are seen in the ERWIN OH intensity observations for the same time period. In this paper, the characteristics of these waves are discussed and whether associated wind signatures are present in the ERWIN wind observations explored. These observations provide the means of identifying the nature of these waves and determining their intrinsic properties. This is of interest for investigating the nature of the dynamical influences forcing the large-scale flow in the mesopause region (~90 km height).

Picon: Standardized data analysis

Peter Argall[1] and R. J. Sica[1]

[1]Department of Physics and Astronomy, University of Western Ontario, London, Canada

Picon is the data analysis program written and used by the Purple Crow Lidar research group at Western. Over the past few months Picon has received some much needed upgrades including a new standard analysis algorithm. The standard analysis algorithm is executed after each data run to produce a set of standard plots. The algorithm then uploads the plots to a web server, allowing easy visualization of the data sets.

Since Picon's inception it has grown to quite a large program, containing 31 analysis algorithms, each containing numerous sub-routines. Added complexity in Picon is found in that it not only processes Purple Crow Lidar data, but also data from the CANDAC Eureka DIAL and CRL lidar. After the latest update, questions were raised as to the effectiveness of our updating procedure. To address this issue, an investigation is underway to determine whether the use of a version control system is appropriate.

Error analysis development for the inversion approach of Rayleigh-scatter atmospheric lidar temperature retrieval using Monte Carlo techniques

Justin Bandoro[1] and R. J. Sica[1]

[1]Department of Physics and Astronomy, University of Western Ontario, London, Canada

The well-established method of the middle atmospheric temperature retrieval from Rayleigh-scatter lidar measurements was first proposed by Hauchecorne and Chanin [1]. It reduces the problem, through several assumptions, to a linear analytical form that can easily be solved for temperature. The uncertainties of the retrieved temperatures can then be found through the laws of error propagation. The main limitation of this method is that temperatures have to be abandoned at the greatest heights due to the requirement of an *a priori* guess of the atmospheric pressure at the uppermost height. Khanna [2] successfully developed a numerical method, using a non-linear inversion approach with grid search optimization, as an alternative to the Hauchecorne and Chanin method but without the disadvantage of discarding the highest temperatures. However measurements of temperatures are not useful if there is no reliable uncertainty analysis associated with it, which Khanna was unable to achieve. Using lidar measurements from the Purple Crow Lidar facility near the The University of Western Ontario, an accurate error analysis method was realized through the use of Monte Carlo techniques along with using a Gaussian distribution to model variations in lidar measurements for the necessary error runs. It was found that the uncertainties reported with this error analysis are comparable and in agreement with the analytical errors from the Hauchecorne and Chanin method. The complicated, though thorough, error analysis method makes it possible to isolate both systematic and random uncertainties and model the effect on the final uncertainty in the temperature profile. Khanna's novel temperature retrieval method complimented with a sound error analysis permits Rayleigh-scatter temperature to be extended up to heights where previously retrievals were not possible [3] and is equal to a similar increase in the power-aperture product of a system by a factor of 4.

[1] Hauchecorne, A. and M.L. Chanin (1980). Density and temperature profiles obtained by lidar between 35 km and 70 km. *Geophys. Res. Lett* 7(8), 565-568.

[2] Khanna, J. (2011). Atmospheric temperature retrievals from lidar measurements using techniques of non-linear mathematical inversion. Master's thesis, The University of Western Ontario.

[3] Khanna, J., J. Bandoro, R.J. Sica, C.T. McElroy (2012). A new technique for retrieval of atmospheric temperature profiles from Rayleigh-scatter lidar measurements using non-linear inversion. *Applied Optics* (in press).

The 2009-10 surge of Lowell Glacier, Yukon, and its historical context

Alexandre Bevington[1] and L. Copland[2]

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[2]Department of Geography, University of Ottawa, Ottawa, Canada

This study aims to better understand the surge-cycle parameters and characteristics of Lowell Glacier, a large surge-type valley glacier in the St-Elias Mountains, southwest Yukon. Measurements of glacier geometry (length, area, and hypsometry) and ice-surface velocities (using VisiCORR, automated statistical correlation software) from repeat satellite images and aerial photographs provide a means to identify and compare surges over the available time period. 98 Landsat images, 2 Advanced Spaceborne Thermal Emissions and Reflectance Radiometer (ASTER) images, 8 aerial photographs, and 2 digital elevation models (DEMs) have been used.

Many of the pre-20th Century surges of Lowell Glacier have dammed the Alsek River, creating an ice-dammed lake that would today flood the current municipality of Haines Junction. Our study has revealed five surges between 1945 and 2012; they occurred in 1948-50, 1968-70, 1983-84, 1997-98, and 2009-10. None of which were large enough to dam the Alsek River. Each of these surges are smaller, shorter and more frequent over time than there predecessor. The maximum surface area of the entire glacier has decreased from 235 km^2 in 1950 to 210km^2 in 2010, and the most recent maximum terminus extent at the peak of the 2009-10 surge was 2.6 km short of the 1950 record. The surface elevation has lowered by 50 to 75m near the terminus, and by 15 to 50 m upglacier from 1976 and 2006. The general trend is that the glacier is receding and that the period between surges is becoming shorter, the ice-surface velocity of the quiescent and active phases are reducing and increasing respectively, the duration of the active phase is becoming shorter, and the terminus advance during the active phase is also becoming shorter.

Study of a future instrument ``TICFIRE`` for observing tenuous clouds in the Polar Regions

Yacine Bouzid[1], J-P. Blanchet [1], and F. Chateauneuf[2]

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[2]Institut national d'optique, Québec City, Canada

The study of the northern climate is imperatively a study of clouds and thin ice clouds, in particular, which have consequences on our climate under mid-latitudes, particularly during the winter storm's season. To achieve measurements of thin ice clouds optical effects on the climate, a new observing far-infrared sensor will be built, it will also calibrate existing models in this unexplored spectral region of the atmosphere from space.

In an ongoing effort for developing the new sensor TICFIRE, different instruments are used as calibrated tools in the overlapped spectral region and a radiative transfer model is used for the unexplored spectral region. In our case, integrated over time at PEARL and over space from CloudSat-CALIPSO provides a unique database for instrument validation. The vantage point of PEARL in terms of vertical and temporal resolutions of the HSRL and the Doppler radar permits a finer investigation of the cloud-precipitation microphysics and upright structure than possible from the satellites alone. As a complement, the space borne instruments allow to extend these investigations on an Arctic, wide scale and pave the way to deeper climate process research.

We present the aims of this study and the tools we use for and some preliminary results will be shown.

Changes in sigma nought reflectivity values from 2003 to 2011 in ENVISAT ASAR Wide Swath imagery of Devon Ice Cap, Nunavut

Tyler De Jong[1]*, L. Copland[1], D. Burgess[2], and W. Van Wychen[1]

[1]Department of Geography, University of Ottawa, Ottawa, Canada
[2]Geological Survey of Canada, Natural Resources Canada, Ottawa, Canada

Glacier facies represent regions of a glacier surface with distinctive surface characteristics (e.g., glacier ice zone, saturation/percolation zone, dry snow zone) that typically reflect spatial variations in surface melt patterns. Backscatter analysis of synthetic aperture radar (SAR) imagery can be used to discriminate facies with different surface properties due to the distinctive reflected signal caused by the elementary scatterers on the surface. Temporal changes in the location of glacier facies are often interpreted as a climate indicator, with facies zones typically increasing in elevation in response to atmospheric warming (Colgan and Sharp 2008). In this study, ENVISAT ASAR Wide Swath imagery is used to monitor the progression of facies zones across Devon Ice Cap from 2003 to 2011. This data is validated against near surface temperature, mass balance data, and Ground Penetrating Radar (GPR) surveys from the northwest sector of Devon Ice Cap. The backscatter images are orthorectified using a Canadian Digital Elevation Data (CDED) DEM of Devon Ice Cap which is used to apply a radiometric terrain correction to return calibrated sigma nought values. Based on these values, the backscatter imagery from autumn (post freeze-up) 2003 to 2011 shows that the greatest progression of facies zones to higher elevations is seen in warm summer years (e.g. 2008 and 2011), yet a general progression in elevation is seen throughout the 2003 to 2011 period.

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Importance and creation of HDF files

Ryan De Vries[1] and R. J. Sica[1]

[1]Department of Physics, University of Western Ontario, London, Canada

The collection of data from the atmosphere can help with the understanding of how the atmosphere is changing, what it is composed of, and what happens in it. The measurements of the atmosphere taken by different research stations are useful on their own but cannot be used to their full potential unless they can be accessed by everyone who is interested. Accessing this data can be difficult without a standard way of processing or storing data.

The Network for the Detection of Atmospheric Composition Change (NDACC) is an organization that allows multiple researchers to store their data in one place so that comparisons can be made between the different sets of data. In order to allow easy viewing of data from different locations NDACC asks that all data be submitted in the form of HDF files.

Hierarchical Data Format (HDF) files were designed by the National Center for Supercomputing Applications (NCSA) in order to assist in storing and sharing scientific data between different operating systems and machines. These files are used because they are a standardized format, independent of the platform used, and are easy to read.

Since starting in May I have been able to implement routines to export our MATLAB data into HDF files which will allow our data for the last 20 years at the Purple Crow Lidar to be integrated into the NDACC database.

Remote sensing of trace gases and aerosols in biomass burning plumes over Eastern Canada during the BORTAS field experiment

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[1]Department of Physics and Atmospheric Sciences, Dalhousie University, Halifax, Canada
[2]Department of Physics, University of Toronto, Toronto, Canada
[3]Environment Canada, Dartmouth, Canada
[4]University of Edinburgh, Edinburgh, United Kingdom
[5]Centre d'applications et de recherches en télédétection, Université de Sherbrooke, Sherbrooke, Canada

Biomass burning is a significant source of carbonaceous aerosols and trace gases to the atmosphere. During the summer of 2011 an international effort, led by the University of Edinburgh, aimed to evaluate the chemistry and dynamics of Boreal forest fire smoke through aircraft, satellite, and ground-based measurements. The Dalhousie Ground Station (DGS), located in Halifax, Nova Scotia, was organized to provide multiple remote sensing measurements of both particulates and trace gases.

On 20 July, 2011, a plume of elevated CO visible in the AIRS satellite images reached the DGS and was clearly detected by two Fourier Transform Spectrometers making solar absorption measurements. FLEXPART trajectory analysis suggests that this CO plume likely originated in fires in Western Ontario and Eastern Manitoba. At the onset of the event, the newly commissioned Dalhousie Atmospheric Observatory DA8 spectrometer detected an additional CO plume at a higher altitude. However, particulate data gathered from a co-located sun photometer and the Dalhousie Raman Lidar system show very low amounts of fine-mode aerosols associated with this airmass.

We will present an overview of this event from multiple points of view and discuss possible explanations for the aerosol/trace gas anomaly, including precipitation as the aerosol removal mechanism for the initially detected portion of the plume.

Transport of CO and aerosols from boreal fire during BORTAS 2011

Debora Griffin[1], J. Franklin[2], M. Parrington[3], C. Whaley[1], J. Hopper[2], G. Lesins[2], K. Tereszchuk[4], K. A. Walker[1,5], K. Strong[1], P. Palmer[3], I. Abboud[7], N. O'Neill[6], C. Clerbaux[8,9], and J. R. Drummond[2]

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[2]Department of Physics and Atmospheric Sciences, Dalhousie University, Halifax, Canada
[3]University of Edinburgh, Edinburgh, United Kingdom
[4]University of York, York, United Kingdom
[5]Department of Physics and Astronomy, University of Waterloo, Waterloo, Canada
[6]Centre d'applications et de recherches en télédétection, Université de Sherbrooke, Sherbrooke, Canada
[7]Environment Canada, Toronto, Canada
[8]Université Versailles St.-Quentin, Paris, France
[9]Spectroscopie de l'Atmosphère, Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Brussels, Belgium

It has been found that emissions from North America, from either natural or anthropogenic origin, have a significant impact on the air quality in Europe. While the impact of anthropogenic emission has been studied previously, the impact from North American boreal fires is not as well-known and is being quantified within the "Quantifying the impact of BOReal forest fires on Tropospheric oxidants and over the Atlantic using Aircraft and Satellites" (BORTAS) project. BORTAS is a three year project having five main goals of: (1) sampling the biomass burning outflow, (2) studying the chemistry and composition within the plume, (3) describing the transport of North American boreal fires, (4) analyzing the impact on oxidant chemistry, and (5) understanding the impact of boreal fires on the global troposphere. The campaign included aircraft flights, ground-based measurements at the Dalhousie Ground Station (DGS), located in Halifax (Nova Scotia), as well as satellite observations. The main species of interest, which are present in boreal fire plumes, are carbon monoxide (CO) and aerosols, as well as ozone (O_3) and ethane (C_2H_6).

On 20 and 21 July 2011, a plume from a boreal fire in Northwestern Ontario over passed Halifax (Nova Scotia), which led to an increase of the total column CO. This enhancement has been detected by two ground-based Fourier Transform Spectrometers (FTS), located at DGS (PARIS-IR and DA8), as well as the space-based IASI instrument. An increase of the fine mode aerosol optical depth (AOD) has been detected by a sun photometer.

The comparison between the two ground-based FTSs, the correlation between CO and the fine mode AOD, are presented here. A comparison between model simulations (using Environment Canada's CMC, FLEXPART and GEOS-Chem) and measurements shows good agreement for the transport of the boreal fire plume, which originated from Northwestern Ontario. Furthermore, other measurement sites (Toronto, Egbert and Pickle Lake) in Ontario have been used to track the plume on its way to Halifax, showing a good agreement between the modelled trajectories and the actual measurements.

Analysis of the near continuss AMS data from PEARL

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[1]Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Canada
[2]Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, Canada
[3]Department of Space Science, Lulea University of Technology, Kiruna, Sweden

The Aerodyne Aerosol Mass Spectrometer (AMS) is an atmospheric instrument capable of providing size and chemical composition in real-time for non-refractory sub-micron aerosol particles. The AMS couples size-resolved particle sampling and mass spectrometric techniques into a single real-time measurement system. An AMS is installed at the polar Environment Atmospheric Research Laboratory (PEARL). It has provided a near-continuous data record from the summer of 2006 to late 2010. The PEARL laboratory is located on a hill, which places it in the free troposphere for most of the time. As a result, the particles detected by the AMS can sometimes originate from long distances away. In previous work, we have shown that sources several thousand km away can contribute to the PEARL AMS measurements. I have analysed the AMS datasets collected during the lifetime of the experiment to identify episodes of high particulate matter at PEARL. This information will allow us to obtain a much more complete picture of the source regions contributing to pollution in the Arctic.

Use of ground-based and satellite lidars and ground-based star-photometry to improve optical information synergy during the Polar night

Liviu Ivanescu[1,2], N.T. O'Neill [2], A. Royer[2], J.-P. Blanchet [1], K. Baibakov [2], T. Duck [3], and C. Perro [3]

[1]Groupe des Sciences de l'Atmosphère, Université du Québec à Montréal, Montréal, Canada
[2]Centre d'Applications et de Recherches en Télédétection & CANDAC, Université de Sherbrooke, Sherbrooke, Canada,
[3]Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Canada

The instrument suite at PEARL (Polar Environment Atmospheric Research Lab) in the high Arctic, near the Eureka Weather Station (80N, 86W), includes the CANDAC Raman lidar (CRL) and a multi-band star-photometer (STP). This location happens to have a CALIPSO overpass within 1 km every 16 days and higher frequencies at moderately greater distances. This represents a rather unique opportunity (on a world-wide scale) to evaluate the synergism of aerosol and cloud optical information between the CALIOP lidar, the CRL and the star-photometer during the depths of the Polar winter. Various illustrations of this synergism will be presented.

We will particularly emphasize that the information provided by the star-photometer (STP) helps to solve the lidar equation, making it an interesting companion instrument for the lidar. Our initial study suggests that the lidar ratio for optically thin polar ice clouds is around 30 sr, without obvious variation as a function of optical depth.

Low level jet streams at the sea ice edge – Numerical experiments using WRF

Stefan Keiderling[1]

[1]Geophysical Institute, University of Bergen, Bergen, Norway

Marine activities at high latitudes are often encountering difficult conditions. Two severe factors are strong winds and resulting rough seas. The goal is to make better forecasts so that operations in the Arctic seas can receive more precise warnings and thus prepare better for potentially dangerous situations. This can be achieved by more research on the special features of the lower Arctic troposphere. Therefore this work will focus on low level jet streams at the sea ice edge. Since this topic has not been much in the focus of previous studies there are rather few observations, hence the first step is to reproduce the simulations made by Grønås and Skeie [1999]. For this purpose the Weather Research and Forecasting Model (WRF) is used.

Cross sections along the ice edge will be made in order to obtain more understanding of the genesis of the low level jet. Once the jet can be tracked from its origin, various numerical experiments will be conducted. The aim is to detect sensitivities to certain atmospheric parameters. If this analysis allows to make solid statements a theory which explains the development of the low level jet has to be formulated. It is supposed that strong boundary layer fronts are causing these strong winds parallel to the ice edge. This boundary layer fronts are explained by the theory of semi-geostrophic frontogenesis. It says that an initial horizontal temperature gradient is intensified by ageostrophic advection. Differential heating leads to pressure gradients across the ice edge which drives an ageostropohic vertical circulation. As a response the geostrophic wind along the ice edge increases. This is the point where the discrepancy between the predicted geostrophic wind and the observed wind arises. After semi-geostrophic frontogenesis the wind maximum is expected close to the surface and slightly off-ice. In contrast, the observed wind is at a height of 925 hPa and ice-inward. To explain this difference is the main goal of this master's thesis.

One possibility for a verification of the results is to use ERAinterim reanalysis data and to create a climatology of ice edge jets events. Then it can be checked if the theory is applicable to different cases. Another alternative is to arrange a field campaign and taking measurements at the sea ice edge, which can be realized by the unmanned aerial vehicle developed at the University of Bergen called Small Unmanned Meteorological Observer (SUMO) [Mayer et al., 2012].

References

Grønås, S. and P. Skeie (1999). "A case study of strong winds at an Arctic front." *Tellus A* **51**(5): 865-879.

Mayer, S., A. Sandvik, et al. (2012). "Atmospheric profiling with the UAS SUMO: a new perspective for the evaluation of fine-scale atmospheric models." *Meteorology and Atmospheric Physics* **116**(1): 15-26.

Validation of ACE-FTS satellite data using ground-based FTIR measurements of CFC-11, CFC-12, and HCFC-22

Felicia Kolonjari[1], E. Mahieu[2], K. A. Walker[1,3], Y. Kasai[4], A. Kagawa[4,5], R. Lindenmaier[6], R. L. Batchelor[7], K. Strong[1], C. D. Boone[3], and P. F. Bernath[8,9]

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[2]Institute of Astrophysics and Geophysics, University of Liege, Liege, Belgium
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Satellite data can be an effective global monitoring tool for long-lived compounds in the atmosphere. The Atmospheric Chemistry Experiment (ACE) is a mission on-board the Canadian satellite SCISAT. The primary instrument on SCISAT is a high-resolution infrared Fourier Transform Spectrometer (ACE-FTS) which is capable of measuring a wide range of gases including key chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) species. These families of species are of interest because of their significant contribution to anthropogenic ozone depletion and to global warming.

To assess the quality of data derived from satellite measurements, validation using other data sources is critical. Ground-based Fourier transform infrared spectrometers (FTIRs) are particularly useful for this purpose. In this study, five FTIRs located at four sites around the world are used to validate the CFC-11, CFC-12, and HCFC-22 data products from ACE-FTS. These species are related; HCFC-22 was the primary replacement for CFC-11 and CFC-12 in refrigerant and propellant applications.

The five FTIR instruments used in this study record solar absorption spectra at Eureka, Canada, Jungfraujoch, Switzerland, Poker Flat, USA, and Toronto, Canada. Details on the instrumentation at each site will be provided. The retrieval of CFC-11, CFC-12, and HCFC-22 are not standard products for many of these FTIRs, and as such, the initial stage of this study is to develop the retrieval of each species. Harmonization of retrieval parameters between the sites is an important step in this process. The development of these retrievals and preliminary results will be presented. Additionally, a new method for the validation of ACE-FTS measurements will be discussed.

Progress on GOSAT validation using data from Eureka and Toronto

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It is always important to compare a new source of data against that of older, well-characterized sources. The launch of the Japanese satellite GOSAT (Greenhouse gases Observing SATellite) in January 2009 has given cause for such a comparison between its data products and other data sets, including those from ground-based observatories. The purpose of this poster is to describe progress on our contribution to validation of the data recorded by the Thermal And Near infrared Sensor for carbon Observation-Fourier Transform Spectrometer (TANSO-FTS) on board GOSAT. The compared data includes measurements of CH_4, CO_2, H_2O, and temperature, derived from both the Short-Wave and Thermal InfraRed (SWIR and TIR) bands. Since GOSAT's launch, a Bruker 125HR FTIR (Fourier Transform InfraRed) spectrometer has measured CH_4 in the mid-IR at the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Canada, as an instrument of the Network for Detection of Atmospheric Composition Change (NDACC). CO_2 and CH_4 columns in the near-IR have also been measured with this instrument since September 2009 as part of the Total Carbon Column Observing Network (TCCON). A Bomem DA8 FTIR spectrometer is used at the University of Toronto Atmospheric Observatory (TAO) NDACC station to measure CH_4 in downtown Toronto, an urban mid-latitude location. ACE (Atmospheric Chemistry Experiment) on SCISAT also provides FTS measurements for global-scale validation of CH_4, H_2O, and temperature profiles. This poster will describe the measurement techniques associated with each system and will present the results of the comparisons between these instruments and GOSAT.

Wind Observations with the E-Region Wind Interferometer

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The E-Region Wind Interferometer (ERWIN) is a Michelson interferometer which has been taking wind measurements at PEARL in Eureka, Nu since 2008. The use of a quad mirror allows for the wind measurements of all five directions (north, south, east, west, and zenith) and of the three emissions (green line, O_2, and OH) every ~2 minutes, with a precision of ~2 m/s. These winds observations provide information about the various waves and tides above Eureka. Due the very high temporal resolution, both lower frequency phenomena (such as tides) and higher frequency phenomena (such as gravity waves) can be observed. A summary of wind observations will be presented.

Retrieval of the particle size distributions of polar stratospheric clouds by ACE-FTS and MAESTRO measurements

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We present a method for the retrieval of the particle size distributions of polar stratospheric clouds (PSC) from the atmospheric extinction measurements of the ACE-FTS and MAESTRO instruments of SCISAT-1. Measurements of atmospheric extinction are made by the high resolution ($0.02 cm^{-1}$) infrared (2.2-13.3μm) Fourier Transform Spectrometer (FTS). The second instrument of SCISAT-1, MAESTRO, operates in the visual to near-infrared spectral region of 280-1030nm. Both instruments operate in solar occultation mode, and combination of the spectra obtained from ACE-FTS and MAESTRO will provide a wider spectral range.

From the measured spectra, the gas phase contributions to extinction are removed to form a residual spectra; that of the condensed phase contributions to extinction. The reference spectra of ice, nitric acid trihydrate ($HNO_3 \cdot 3H_2O$) and supercooled ternary solution (H_2SO_4/ HNO_3/H_2O) are determined by Mie theory using laboratory results for the refractive indices of each component respectively. A least-squares problem is formulated with the use of the measured and reference spectra. The problem is inverted by a non-negative least-squares fitting procedure to determine the particle size distribution of each component of the PSC.

Measuring Radiation and Trace Gases in the Arctic Year-round using the E-AERI

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The Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) is a moderate resolution (1 cm^{-1}) Fourier transform infrared (FTIR) spectrometer for measuring the absolute downwelling infrared spectral radiance from the atmosphere between 400 and 3000 cm^{-1}. The extended spectral range of the instrument permits monitoring of the 400-550 cm^{-1} (20-25 μm) region, where most of the infrared surface cooling currently occurs in the dry air of the Arctic. Spectra from the E-AERI provide information about the radiative balance and budgets of trace gases in the Canadian high Arctic. Total columns of trace gas species (e.g. O_3, CO) have been retrieved year-round using a new modified version of the SFIT2 retrieval algorithm and show good agreement with measurements from other ground-based spectrometers. The instrument was installed at the Polar Environment Atmospheric Research Laboratory (PEARL) Ridge Lab at Eureka, Nunavut, in October 2008 where it acquired one full year of data. Measurements are taken every seven minutes year-round, including polar night when the solar-viewing FTIR spectrometers at PEARL are not operated. This allows E-AERI trace gas measurements to fill in a gap in the PEARL dataset during polar night. A similar instrument, the University of Idaho's Polar AERI (P-AERI), was installed at the Zero-altitude PEARL Auxiliary Lab (0PAL) from March 2006 to June 2009. Measurements from these two instruments have demonstrated the impact of clouds, water vapour, ice crystals, etc., on the radiative budget at two different altitudes.

Dr. Neil Trivett global atmosphere watch research station

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Alert, Nunavut is the home of the Dr. Neil Trivett Global Atmosphere Watch Research Station. Located at 82º28'N, 62º30'W on the northeast tip of Ellesmere Island, Canada, it is the most northern station in the GAW program and its' isolated location is ideally situated for the monitoring of global atmospheric pollutants.

The Global Atmosphere Watch (GAW) program of the World Meteorological Organization (WMO) is a partnership involving approximately 80 countries. The GAW program seeks to understand and control the increasing influence of human activity on the global atmosphere. Observations started in 1975 as Canada's obligation to support the United Nations Environment Program (UNEP) following the 1972 Stockholm Conference on the Human Environment. The GAW Lab in Alert is now one of three premier remote sites in the United Nations WMO GAW Program, having joined the program in 1986.

This poster will outline some of the more important scientific advances from Alert that have led to improved understanding of surface ozone depletions, mercury transport and depletion, greenhouse gas trends, emergence and presence of new toxins such as flame retardant pollutants, and a more thorough comprehension of Arctic haze origins. A brief project summary, research advancements, select pictures of the lab and the instruments utilized in Alert, and some relative plots will be displayed outlining the work being accomplished in the lab.

Assessment of Increasing Open Water Leads Along Northern Ellesmere Island

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Weekly Canadian Ice Service Digital Archive (CISDA) and MODIS satellite images were extracted and analyzed to quantify the occurrence of open water leads and the time period of their existence. For the purpose of this study, three types of sea ice concentrations were examined *Open Water*, consisting of open water and bergy water, *Very Open Drift*, consisting of concentrations from 1/10 to 3/10, and finally *open Drift*, which consisted of sea ice concentration of 4/10 to 6/10.

Open water leads were first observed during the summer of 1999 and were detected each following summer, with the exception of 2006. These open water leads have been observed during the record low Arctic sea ice extent and generally during negative phase of the Arctic oscillation. Factors that have been associated with these leads are the rising surface air temperatures and persisting southerly winds. Open water leads has been associated with late summer ice calving events which occurred in 2002, 2005, 2007, 2008, 2010, and 2011. The 13 year record of open water leads shows an interannual variability in the sea ice concentration along the shore line. The data shows that these events are occurring earlier in the summer melt season.

Polar Sunrise 2012 Cloud Depolarization with the CANDAC Rayleigh-Mie-Raman Lidar at Eureka, Nunavut

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During polar winter, in the absence of incoming solar radiation, clouds can dominate the atmospheric radiation budget. Cloud particle phase, to which this balance is particularly sensitive, must be known in order to produce a correct estimate of climate. There is still great uncertainty in the relative abundance of liquid and solid particles in polar clouds, but depolarization measurements by the CANDAC Rayleigh-Mie-Raman Lidar (CRL) at Eureka, Nunavut (80°N, 86°W) are improving our understanding in this area.

The CRL is a versatile instrument with eight detection channels, capable of measuring 532 nm (visible) and 355 nm (ultraviolet) elastic and nitrogen Raman backscatter, aerosol extinction, water vapour mixing ratio, tropospheric temperature profiles, as well as particulate density and colour ratio. In 2010, a new depolarization channel was added to determine the extent to which the polarization state of the lidar beam is changed by scattering interactions with cloud particles in the sky. Comparing the component of the backscattered lidar return which is perpendicular to the polarization of the transmitted laser, to that which is which is returned parallel to it, provides the ability to discern between ice crystals and liquid water droplets in polar clouds.

Many depolarization-capable lidar systems use two separate depolarization detector channels: one for parallel and the other for perpendicular returns. During the 2012 Polar Sunrise campaign, a simplified setup was tested which uses a single dedicated depolarization channel for parallel returns, and which, instead of requiring a second depolarization-only channel, makes use (without modification) of the existing CRL 532 nm elastic backscatter channel. Combined analogue and photon-counting detectors in both channels allow for spatial resolution of 7.5 m and temporal resolution of 1-minute from the ground to 10 km altitude.

A month-long time series from March 2012 provides context for the more detailed polar cloud depolarization case studies which will be presented.

Analyzing Gravity Waves from Images Produced by the All Sky Imager

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The All Sky Imager (ASI) is located at the PEARL station in Eureka, Nunavut. With its 180° field of view, the ASI provides information on airglow and auroral emissions in the mesosphere. The imager is currently equipped with a back illuminated E2V CCD 77-00 (scientific grade 1, MPP, 1024x1024 pixels) based Pixis camera from Princeton Instruments. The filterwheel of the ASI contains eight filters: empty, 589.3 nm to observe sodium nightglow, 572.5 nm to observe background light, 720 nm to 910 nm to observe hydroxyl (OH) nightglow emissions, 427.8 nm for aurora detection, 557.7 nm for atomic oxygen green line nightglow, 630.0 nm for atomic oxygen red line nightglow, and closed to detect the dark counts.

Gravity waves can be detected once the raw images of the ASI are corrected , for example by removing the stars, accounting for the Van Rhijn and atmospheric extinction effects, and undergoing a coordinate transformation. Once these are preformed, the images are much clearer and possible waves can now be identified, with the main focus being the OH region. Keograms are then created in order to view the activity for each day. The method for creating keograms is done by extracting vertical columns from single all-sky images and placing them in succession with each other. Consequently, time ends up along the horizontal axis, and the geographic North/South or East/West is displayed as the vertical axis. This allows waves of various scales to be identified on a daily basis. The code for creating keograms has been modified and improved in order to produce the best visual representation of any gravity waves that are detected. This paper will describe this method of analysis and present some results.

Investigating the Effects of Line-mixing on Eureka Spectra

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The Total Carbon Column Observing Network (TCCON) is a network of Fourier transform spectrometers (FTS) that use a non-linear least squares spectral fitting algorithm (called GFIT), for the analysis of solar spectra. From these spectra one can retrieve precise amounts of column-averaged abundances of CO_2 (XCO_2). The Bruker IFS 125HR FTIR (which will be called PEARL FTS) at the Polar Environment Atmospheric Research Laboratory (PEARL), near Environment Canada's Eureka weather station, has been making TCCON near-infrared measurements since September 2009. The Eureka instrument joined TCCON in July 2010 and is the most Northern site in the network.

Measurements of XCO_2 made near polar sunrise and sunset are made through a large amount of air mass. One would expect XCO_2 to vary by ~0.1% in 1 hr (Washenfelder et al., 2006), but measurements of XCO_2 made through a large amount of air mass can vary by as much as 6 ppm in the span of 2 hrs due to line-mixing. Line mixing occurs at pressures where lines are broadened enough to overlap, altering the spectral shape (Boulet., 2004). Excess CO_2 is retrieved from absorption in the troughs between lines where line mixing has its largest effects (Hartman et al., 2009). There has been extensive work done by Niro et al. (2005) to develop software to take line-mixing into account in the spectral fitting process. Lamouroux et al. (2010) updated the line-mixing software with the spectroscopic parameter from HITRAN 2008. The updated code improved the spectral fits of laboratory spectra but needs to be tested on atmospheric spectra.

In this study I used the line-mixing software (Lamouroux et al., 2010), implemented into GFIT to retrieve XCO_2 from solar absorption spectra recorded by the PEARL FTS for different air masses. At high amounts of air mass, solar zenith angle (SZA) from 85° to 87°, including line-mixing for CO_2 reduces XCO_2 by 1.4-2.3 ppm. There is an improvement in the spectral fits when the line mixing software is used, but the systematic residual is corrected better in the R-branch than the P-branch. Using line-mixing for CO_2 reduces XCO_2 by 0.3-0.37 ppm for SZA from 68° to 72°. The residuals are slightly worse when using line-mixing with spectra that were measured at a moderate amount of air mass.

Making SPÉIR move as freely as air

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SPÉIR is a millimeter wave emission radiometer being developed by the University of Toronto Laboratory for Atmospheric Spectroscopy And Applications (LASAA). This instrument, currently in design, is intended to be automated and will be deployed in the Canadian High Arctic (planned for the Polar Environment Atmospheric Research Laboratory (PEARL) near Eureka, Nunavut). This instrument will provide vertical profiles for the species O_3, ClO, HNO_3, and N_2O, by analyzing specific rotational transitions in the 265-280 GHz region of the spectrum. The device has a 1-GHz spectral range with 1000 1-MHz channels, and features an ultra Gaussian feed horn, an advanced Superconducting-Insulating-Superconducting (SIS) mixer and local oscillator. The focus of this presentation is to outline the motion control systems and Graphical User Interfaces (GUIs), which are being written and developed for long-term automated operation. Motion systems are required for the purpose of tipping curve calibration, two-body brightness temperature calibration, and channel nonlinearity correction. Tipping curve calibration accounts for signal attenuation due to tropospheric water vapour. Two-body brightness temperature calibration uses two known blackbodies to determine linear voltage to brightness temperature conversion. Channel nonlinearity correction switches between reference and signal beams for the purpose of evaluating gain drift and channel nonlinearity in the less abundant and weakly defined transitions. The instrument is currently in final design stages.

Pan-Arctic Water Vapour Measurements using the Microwave Humidity Sounder

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The Microwave Humidity Sounder (MHS) is an instrument on board the polar orbiting NOAA-18 and MetOp-A satellites. MHS measures brightness temperature with five channels near 183 GHz for the purpose of measuring water vapour without significant interference from clouds. The water vapour retrieval technique used is independent of surface emissivity and favours low concentrations of water vapour (< 7 mm) optimizing it for Arctic winter measurements. A calibration is produced using winter precipitable water measurements from the G-Band radiometer (GVR), located in Barrow, Alaska (71N, 156W).

The CANDAC Rayleigh-Mie-Raman lidar (CRL), located in Eureka, Nunavut (80N, 86W) is an eight-channel lidar that measures profiles of cloud and aerosol optical properties, water vapour mixing ratios, and depolarization. A case study shows a thick precipitating ice cloud as seen by the CRL, which extends from the surface to Tropopause. Pan Arctic plots using the MHS in combination with FLEXPART back trajectories indicate two possible water vapour masses contributing to the formation of the thick ice cloud.

The MHS dataset will be used to provide several different analyses such as the Pan-Arctic plots, which can be produced twice-daily with 15 km resolution at nadir. It will be able to give insight on the dehydration greenhouse feedback effect by measuring changes in water vapour spatially for short time periods. A water budget for the Arctic can also be constructed using its high spatial resolution.

Earth rotation, global warming and mantle viscosity: physical insight in the glacial isostatic adjustment process

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Glacial isostatic adjustment (GIA) refers to the changes in the Earth's shape and gravitational field due to variations in surface mass load, which is largely dominated by the influence of the deglaciation following the Last Glacial Maximum. The process may be accurately computed using the Sea Level Equation (SLE) formalism, which describes the way that water must spread over the globe to ensure that the ocean surface remains a gravitational equipotential surface. This formalism depends on two fundamental inputs: a precise history of space-varying ice sheet loading and a model of the viscosity of the Earth's mantle. Recent analytical solutions of this formalism, which includes only the influence of the deglaciation following the last glacial period, shows significant discrepancies with respect to geodetically-inferred values of the time derivatives of the degree two and order one Stokes coefficients of the spherical harmonic expansion of the Earth's gravitational field, which can be obtained from decades-long records of the planet's orientation. These discrepancies may be linked to additional rotational forcing induced by modern-day land ice melting in various regions, including the Arctic Archipelago. Here, recent progress in determining this connection is presented, as well as better constraints on radial variations of mantle viscosity in the context of developing accurate relative sea-level history predictions.

Observation system simulation experiments for SPÉIR;A mm-wave receiver for atmospheric research

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A ground-based millimetre-wave radiometer is currently being developed at the University of Toronto which will measure ozone and the trace species involved in its chemical destruction. The instrument is to be housed at Eureka, Nunavut, Canada (80 degrees North) and will measure emissions from the Arctic stratosphere. The target species are ozone (O_3), chlorine monoxide (ClO), nitric acid (HNO_3), and nitrous oxide (N_2O). ClO is involved in all of the reaction cycles in which chlorine radicals, originally parted from chlorofluorocarbons, catalytically destroy ozone. Detection of ClO requires a precise measurement system and the radiometer will use a sensitive superconductor-insulator-superconductor (SIS) detector enabling the retrieval of vertical atmospheric concentration profiles. In this contribution I will show results of a detailed theoretical study of the retrieval of trace gas profiles using an optimal estimation inversion technique. The results describe the capability of the observing system through detection and retrieval altitude limits, altitude resolution, error characterisation, and repeated simulation statistics. Continuous ground-based measurements in the Arctic are essential to furthering understanding of the processes involved in stratospheric chemistry and the data set obtained with this instrument will greatly complement that already available from instruments operating in Eureka.

Recent volume and mass changes of Penny Ice Cap (Baffin Island, Nunavut) determined from repeat airborne laser altimetry

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Recent gravity based satellite observations show that Baffin Island is the second highest contributor to global sea level rise outside of the main ice sheets, after Alaska. However, there are no long term surface mass balance measurements available for Baffin Island glaciers to verify these space-borne observations and provide a historical context. In the absence of such data, air-borne measurements can be used in combination with ice core data and in-situ ground penetrating radar surveys to evaluate historical and recent trends in ice cover changes. Here, we use repeat laser airborne altimetry surveys conducted in 2000 and 2005 to estimate current volume and mass reduction rates of Penny Ice Cap, the southernmost large ice cap on Baffin Island (~66°N). This work builds on previous surveys for the period 1995-2000 [Abdalati *et al.* (2004) *JGR* 109: F04007.] Volume changes are extended to present day using elevation data collected on Penny Ice Cap in 2012. Surface elevation changes along altimetry lines are extrapolated to the entire ice cap using a digital elevation model (DEM). Changes in areal extent of the ice cap are constrained using satellite imagery (e.g. Landsat). From these data and using firn density profiles measured in cores, we estimate the total mass wastage of the ice cap and its contribution to sea level rise.

A Decade (2002-2011) of Solar Absorption Spectra through FTIR Spectrometry at TAO

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The University of Toronto Atmospheric Observatory (TAO) serves as a Northern Hemisphere mid-latitude station in the international Network for the Detection of Atmospheric Composition Change (NDACC). Situated on the 16th floor of the Burton Tower of the McLennan Physical Laboratories at the University of Toronto, it is located at 43.66° N, 79.40° W and is 174 m above sea level. The ABB Bomem DA8 Fourier Transform InfraRed (FTIR) spectrometer is the primary instrument at TAO and has been operating since October 2001 with daily measurements being taken since May 2002.

The FTIR spectrometer retrieves and records daily solar absorption spectra for measuring the presence of stratospheric and tropospheric trace gases. This is performed through calculating the difference between the measured atmospheric spectrum and a simulated spectrum. The simulated spectrum is generated with the help of line parameters, an initial profile estimate (*a priori*) and a “zpt” profile (vertical profile of pressure (p) and temperature (t) with respect to altitude (z)). The difference between the measured and simulated spectra is known as the residual. The *a priori* volume mixing ratio (fractional volume of gas per unit volume of air) profile of the gas of interest is adjusted iteratively to minimize the residual in a process known as a retrieval.

The FTIR spectrometer at TAO has high spectral resolution (0.004 cm^{-1}) and is able to record solar absorption spectra over a wavenumber range of 720-8500 cm^{-1}. It has the ability to measure the abundances of CH_4, HCl, HF, N_2O, NO, NO_2, O_3, CO, C_2H_6 and HCN in the atmosphere. This is facilitated by a suntracker that is able to actively and passively track the position of the Sun in the sky. Actively, it uses four photodiodes, which are able to sense solar radiation, to provide a feedback loop to reposition the suntracker. Passively, it is able to calculate the position of the Sun in the sky based on the day of year and the time of day. Through the use of a series of mirrors, the suntracker redirects and focuses the solar radiation through one of six NDACC specified filters. From these solar absorption spectra, it is possible to derive the vertical profile distribution and total and partial column densities (mass of substance/unit area integrated along the path through the atmosphere). This poster will present time series resulting from the past decade of column measurements of C_2H_6, CH_4, CO, HCl, HF, N_2O and O_3 recorded with the TAO FTIR spectrometer.

Validation of OSIRIS mesospheric temperatures

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The Optical Spectrograph and InfraRed Imaging System (OSIRIS) on the Odin satellite is currently in its 12th year of observing the Earth's limb. For the first time, continuous temperature profiles extending from the stratopause to the upper mesosphere have been derived from OSIRIS observations of Rayleigh-scattered sunlight. OSIRIS temperatures are in good agreement with coincident temperature profiles derived from other satellite and ground-based measurements. In the altitude region of 55-80 km, OSIRIS temperatures are typically within 4-5 K of those from the SABER, ACE-FTS, and SOFIE instruments on the TIMED, SciSat-I, and AIM satellites, respectively. OSIRIS temperatures are typically within 2 K of those from the University of Western Ontario's Purple Crow Lidar in the altitude region of 50-79 km.

Returning an Atmospheric Emission Radiometric Interferometer -eXtended (AERI-X) to Service

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The Atmospheric Emission Radiometric Interferometer -eXtended (AERI-X) is a Michelson-type Fourier Transform Spectrometer (FTS) with a spectral resolution of 0.1 cm^{-1}; 10 times higher resolution than the more common Atmospheric Emitted Radiance Interferometer (AERI) spectrometers that this instrument is based on. Higher resolution allows for improved stratospheric chemistry measurements and radiative-transfer measurements. The AERI-X has a spectral range from 650 to 1250cm^{-1} (8.0 to 15.4 microns). It was originally designed to study the differences between Arctic and Antarctic stratospheric chemistry at the Arctic Stratospheric Observatory (AStrO) at 80°N and the South Pole, respectively. The AERI-X was last operated in Eureka in 2002, and in Antarctica 2003-2006. Returning the AERI-X to services will allow for the comparison of measurements with the Extended Range Atmospheric Emitted Radiance Interferometer (E-AERI), which has a 1.0 cm^{-1} spectral resolution. Software and hardware upgrades are required to modernize the AERI-X. Hardware improvements under investigation include replacement of the signal electronic, digitizing chain, and housekeeping sensor with modern equivalents. Software upgrades under consideration include moving from a DOS 5 based system to a modern Linux kernel using Xenomai for achieving the deterministic real-time performance necessary to run an FTS and Comedi for data acquisition.

Ice Melt Process in Canadian Arctic Archipelago: 1989 to 2010

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The minimum September sea ice extent for the Canadian Arctic Archipelago (CAA) region exhibits significantly different year-to-year variability when compared to other open sea Arctic regions due to the geographic arrangement of the islands. Thus, regional specific analyses are needed to understand the sea ice melt processes for the CAA. The maximum possible sea ice area for the CAA region is fixed at 100 percent of the water area at the end of winter due to land constraint. The summer minimum sea ice extent in the CAA depends mainly on the amount of melt in spring and summer plus the regional advection of ice from the Beaufort Sea and Arctic Ocean. We provide a detailed analysis of the daily sea ice extent change for the CAA region focusing on the April to August interval for each year for the 1989-2010 observational period. The melt process has been divided into four phases: melt onset phase, quick melt phase, ice import phase and steady melt phase. These phases are significantly different from each other in terms of temporal progression. A possible ice melt mechanism is proposed to explain the four-phase process. The start date of the quick melt phase for a year is a good indicator of the amount of ice loss for that year. The net surface radiation accumulated with the CAA region is also significantly related to the timing of the quick melt phase.

Temporal Analysis of Atmospheric Gravity Waves using an All Sky Imager

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The PEARL All Sky Imager (PASI) is a CCD imager system which views 6 different spectral regions using narrow band interference filters. These target emissions at: 589.3 nm (for Na), 572.5 nm (background), 427.8 nm (N_2+ for aurora), 557.7 nm (oxygen green line), 630.0 nm (oxygen red line) and 720-910 nm notched at 865 nm (for OH). These filters alternate sequentially between the different positions on the filter wheel and the OH filter. The imager is designed to take an image roughly every minute and is stationed at a polar station located at Eureka, Nunavut.

This paper reports on a study of phase speed and period of atmospheric gravity waves and the correlation between propagation direction and these quantities. To accomplish this, the occurrences of waves in terms of amplitude, spatial phase and time are defined. Comparison of the spatial phase information between subsequent occurrences of the wave provides information on the propagation direction and phase speed. As more instances of waves are determined, a better estimate of the angular frequency of the wave is found. The data set used was taken during the winter season of 2008-2009. This paper reports on the data analysis approach and the wave characteristics during this time period. Of particular interest are results taken during the major stratospheric warming of January 2009.

Intercomparison of atmospheric water vapour measurements at Eureka

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Water vapour plays a critical role in atmospheric dynamics and the Earth's radiative balance. However, its concentration, evolution and transport processes are still poorly understood.

One of the instruments at the Polar Environmental Atmospheric Research Laboratory (PEARL) in Eureka, a Bruker IFS 125HR Fourier transform infrared (FTIR) spectrometer, is able to measure many trace gases, including water vapour. The PEARL FTIR spectrometer recently joined the new MUSICA network (Multi-platform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric water). MUSICA aims to create a consistent, long-term, high-quality, and area-wide observational dataset to help inform climate models and answer outstanding questions regarding the atmospheric water cycle. The PEARL FTIR dataset has been analyzed using the PROFITT trace gas retrieval algorithm following the analysis protocols developed for MUSICA. The goal of this research is to evaluate these FTIR water vapour measurements in the Canadian high Arctic. This will involve validation of the FTIR dataset using other ground-based PEARL instruments as well as satellite measurements.

This poster will present results of this intercomparison project, including an examination of total column measurements of water vapour retrieved using the PEARL FTIR spectrometer, a microwave radiometer, sunphotometer and integrated radiosonde measurements, as well as FTIR profile comparisons with radiosonde, lidar, and satellite measurements made by the Atmospheric Chemistry Experiment (ACE).

Validation of Purple Crow Lidar Stratospheric Water Vapour Measurements

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The Purple Crow Lidar (PCL) has recently participated in a stratospheric water vapour validation campaign with the NASA/GSFC Atmospheric Laboratory for Validation/Interagency Collaboration and Education (ALVICE). This field campaign took place from May 23rd to June 10th 2012 and resulted in 57 hours of measurements taken over 12 clear weather nights. On each night a minimum of one RS92 radiosonde was launched and a total of three CFH sondes were launched over the course of the campaign.

The main focus of the campaign was to compare and validate Raman lidar systems for the incorporation of water vapour data into the Network for the Detection of Atmospheric Composition Change (NDACC) data set. Preliminary results will be shown.

Investigation of Planetary Waves and Large Scale Atmospheric Tides in E-Region Wind Interferometer-II Wind Speed Data

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The E-Region Wind Interferometer-II (ERWIN-II) measures mesospheric winds (~90km) by determining the Doppler shift of airglow emissions. These emissions are a result of photochemical processes in the mesopause region. The particular emission lines studied are the greenline or atomic oxygen (557.7nm) at an altitude of ~97km, O_2 (866.0nm) at an altitude of ~94km, and OH (843.0nm) at an altitude of ~87km. With the use of a quad mirror, wind measurements at all three altitudes are taken in five directions simultaneously (north, south, east, west, zenith) on a cycle of ~3 minutes.

Tidal signatures, particularly tides with periods greater than 8 hours, and planetary waves are investigated by analyzing the wind speed data using two different methods. The first method is a least mean squares algorithm with sinusoids of a given set of frequencies. This results in obtaining the most dominant tidal frequencies and their amplitudes, as well as the frequencies of the most dominant planetary waves. The second method used to analyze the data is a Lomb-Scargle periodogram algorithm.

ERWIN-II wind speed data from late November 2010 to February 2011 is analyzed using the two methods previously mentioned. When comparing the results, the two methods seem to agree well. In both analysis methods, planetary waves with periods in the range of around 20 days, 10 days, 8 days, 5 days, 4 days, and 2 days are observed at much larger amplitudes than the most of the dominant tides. By far the most dominant tide observed is the semidiurnal tide, with diurnal and terdiurnal tides present as well, but not nearly as dominant.

Multi-Axis Differential Optical Absorption Spectroscopy measurements in the Canadian High Arctic

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A ground-based, UV-visible triple-grating spectrometer has been deployed at the Polar Environment Atmospheric Research Laboratory (PEARL) in the Canadian High Arctic. This instrument, the PEARL-GBS, was permanently installed at PEARL in August 2006 as part of the refurbishment of the laboratory by the Canadian Network for the Detection of Atmospheric Change (CANDAC). Since then, the instrument has been making continuous measurements, with the exception of during polar night. Vertical columns of ozone and NO_2 can be retrieved year-round. A Sun-tracker was installed directly above the PEARL-GBS in 2008, enabling Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) and direct-Sun observations.

This work will present a brief introduction to the bromine explosion events (BEEs), which often happen in the Polar regions in the spring. Many open questions related to the BEEs will be discussed. Also, this poster will show the technical aspects of MAX-DOAS and the preliminary BrO measurements at PEARL. Finally, this work will show my future Ph.D. research plans related to study the BEEs.

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Formation of Small Gas Phase Carbonyls from Heterogeneous Oxidation of Polyunsaturated Fatty Acids (PUFA)

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Organic substances in sea surface microlayers are composed of proteins, polysaccharides, humic-type material and surface active lipids. Fatty acids, as a main component of lipids, have been detected in considerable amounts in sea surface water samples. In addition, fatty acids (FAs) are emitted into the atmosphere from gas and diesel powered vehicles, cooking and plants. Field measurements have suggested that FAs, including polyunsaturated fatty acids (PUFA), could make up an important contribution to the organic fraction of atmospheric aerosols. Due to the existence of carbon-carbon double bonds in their molecules, PUFA are believed to be important in phytoplankton and zooplankton and represent fresh material in sea water. Moreover, they are highly reactive towards atmospheric oxidants such as OH and NO_3 radicals and ozone, which will contribute to aerosol hygroscopicity and cloud condensation nuclei activity.

Previous work from our group has shown that small carbonyls formed from the heterogeneous reaction of linoleic acid (LA) and linolenic acid (LLA) thin films with gas-phase O_3. In the present study, an online proton transfer reaction mass spectrometry (PTR-MS) and high resolution PTR-MS (HR-PTR-MS) have been used to investigate similar reaction system on the heterogeneous ozonolysis of LA thin film on sea water. In addition to the previously reported carbonyls, malondialdehyde (MDA), a source of reactive oxygen species that is mutagenic, has been identified as a product for the first time. Other small dicarbonyls, e.g. glyoxal, have been detected using a newly built Teflon chamber in our group coupled with an off-line gas chromatography-mass spectrometry (GC-MS) analysis. In this presentation an investigation on small carbonyls production from ozonolysis of real sea surface water will also be presented.

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Identifying the mesoscale horizontal and vertical distribution of reactive halogen oxides in polar regions

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It is been known for quite a while that reactive halogen species (RHS) such as bromine monoxide (BrO), but also chlorine and iodine oxides have a profound impact on the chemistry of the polar tropospheric boundary layer. Especially during springtime, BrO regularly causes the complete depletion of ozone in the lowermost ~1000m through autocatalytic photochemistry during so called Ozone Depletion Events (ODEs).

However, many important aspects of these processes are still not understood, including the release mechanism from the sources into the troposphere and the vertical and horizontal distribution of said species during ODEs.

Another disparity not understood is the presence of IO in coastal areas of Antarctica, which can be seen both from satellite observations and ground-based measurements, while in the Arctic it is virtually completely absent, pointing to a biogenic source.

To investigate these questions Differential Optical Absorption Spectroscopy is employed in this work in the Arctic (Alert, Nunavut and Barrow, Alaska) and coastal Antarctica for remote sensing using ground-based and airborne geometries, as well as for point measurements using optical resonators to get a high spatial resolution.