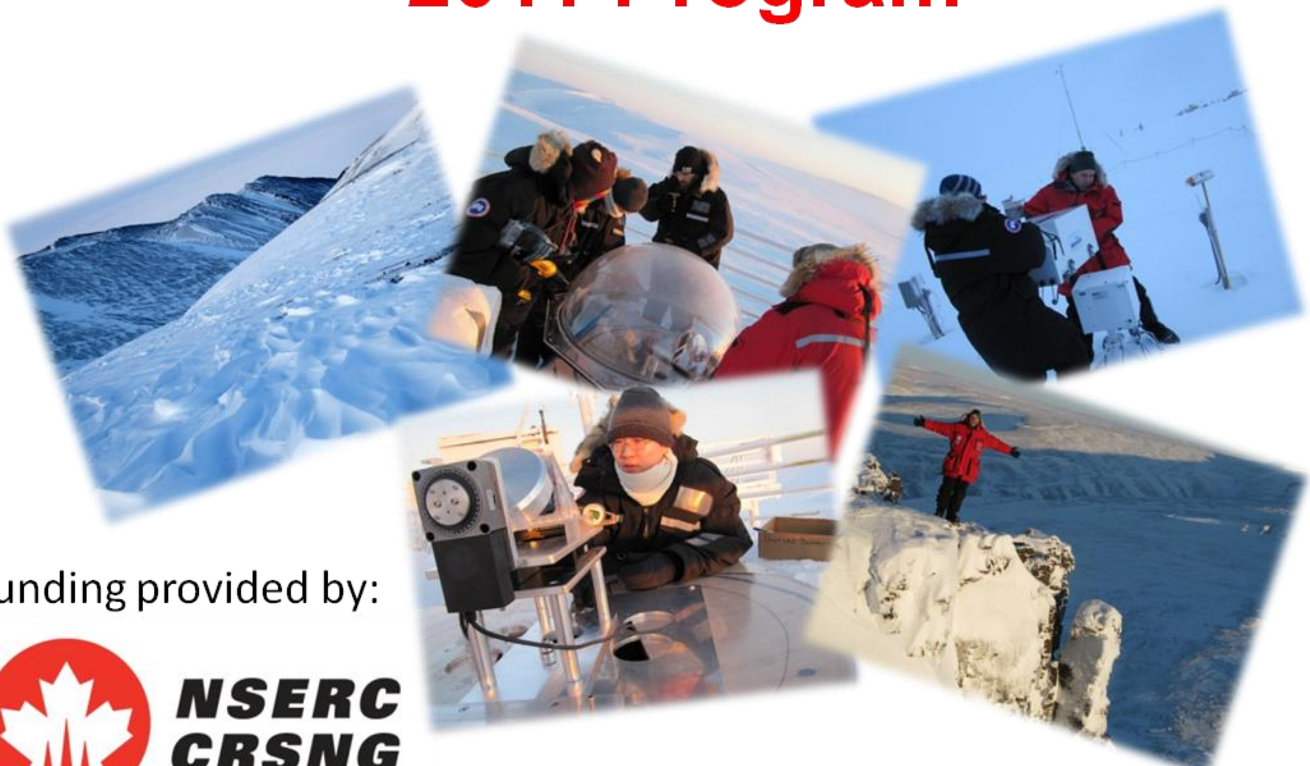
NSERC CREATE
Training Program in Arctic Atmospheric Science

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

Summer School in Arctic Atmospheric Science

July 11-15, 2011 • Nottawasaga Inn • Alliston, Ontario, Canada

2011 Program



Funding provided by:

NSERC
CRSNG

NSERC CREATE Training Program in Arctic Atmospheric Science

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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, a Co-operative Education 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.

Nov. 2010 Research Symposium, Halifax

Summer School Speakers

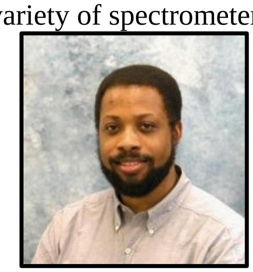
Peter Calamai is an adjunct research professor in the School of Journalism and Communication at Carleton University, a contributing editor at Cosmos, and a member of the Editorial Advisory Committee of the Science Media Centre of Canada. He was the Toronto Star's national science reporter from 1998 to 2008.

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.

Pierre Fogal is the PEARL Site Manager and the CANDAC Manager of Operations. He is a physicist working in the Air Quality Research Division at Environment Canada in Toronto. He has been active in measuring atmospheric composition from Eureka to the South Pole using a variety of spectrometers.

David Hik is a professor at the University of Alberta and holds a Canada Research Chair in northern ecology. He serves as President of the International Arctic Science Committee and was previously Executive Director of the Canadian International Polar Year Secretariat.

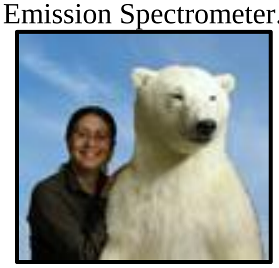
Matthew Hitchman is a professor of Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison. He studies the dynamics of atmospheric motions, with a focus on the middle atmosphere and stratosphere-troposphere exchange.



Dylan Jones is an associate professor at the University of Toronto and holds a Canada Research Chair in atmospheric physics. He is a member of the Steering Committee for the GEOS-Chem model and a Collaborator for the Tropospheric Emission Spectrometer.

Markus Rex is a physicist in the Division of Climate Sciences and Atmospheric Circulations at the Alfred Wegener Institute in Potsdam. He is head of group, PI for SCOUT-O3, and has research interests in stratospheric chemistry and dynamics.

Ralf Staebler is a research scientist in the Air Quality Research Division at Environment Canada in Toronto. He is Co-PI of the IPY OASIS-Canada project, and his main interests lie in micrometeorology, flux and trace gas measurements.



Taneil Uttal is leader of the Polar Processes Research group in the NOAA Earth Systems Research Laboratory at Boulder. She is leading NOAA's effort to establish permanent Arctic atmospheric observatories as a part of the SEARCH and IASOA Programs.

Summer School Students

	Name	Institution
(1)	Cristen Adams (PhD)	University of Toronto
(2)	Justin Bandoro (CREATE/NSERC summer intern)	University of Western Ontario
(3)	Chris Caldow (PhD)	University of Wollongong
(4)	Kuo-Hsien (Michael) Chang (PhD)	University of Guelph
(5)	Lin Dan (MSc)	University of Toronto
(6)	Anthony Dineen (MSc)	York University
(7)	Zoya Dobrusin (MSc)	York University
(8)	Marine Favier (CREATE summer intern)	University of New Brunswick
(9)	Jonathan Franklin (PhD)	Dalhousie University
(10)	Anya Gawor (MSc)	University of Toronto at Scarborough
(11)	Melissa Gervais (PhD)	McGill University
(12)	Liviu Ivanescu (MSc)	Université de Sherbrooke
(13)	Jaya Khanna (MSc)	University of Western Ontario
(14)	Jenny Kliever (CREATE summer intern)	University of Toronto
(15)	Felicia Kolonjari (PhD)	University of Toronto
(16)	Sam Kristoffersen (MSc)	University of New Brunswick
(17)	Kristina Luus (PhD)	University of Waterloo
(18)	Zen Mariani (PhD)	University of Toronto
(19)	Michael Maurice (CREATE summer co-op)	University of Toronto
(20)	Emily McCullough (PhD)	University of Western Ontario
(21)	Joseph Mendonca (MSc)	University of Toronto
(22)	Colleen Mortimer (PhD)	University of Alberta
(23)	Camille Pagniello (CREATE summer intern)	Dalhousie University
(24)	Boris Pavlovic (CGCS summer intern)	University of Toronto
(25)	Chris Perro (PhD)	Dalhousie University
(26)	Anne Wang Petersen (MSc)	University of Copenhagen
(27)	Niall Ryan (PhD)	University of Toronto
(28)	Mehrnaz Sarrafzadeh (MSc)	York University
(29)	Patrick Sheese (PDF)	University of Toronto
(30)	Majbritt W. Sørensen (MSc)	University of Copenhagen
(31)	Heidi Villadsen (MSc)	University of Copenhagen
(32)	Dan Weaver (Intern)	University of Toronto
(33)	Adrienne White (MSc)	University of Ottawa
(34)	Robin Wing (MSc)	University of Western Ontario
(35)	Jun Yang (PhD)	University of Toronto (visiting), Peking University

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.

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

CSA ASC

NSRIT
Nova Scotia Research and Innovation Trust

NORTHERN SCIENTIFIC TRAINING PROGRAM

Polar Continental Shelf Project (PCSP)

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Climate Reference Observation Points (CROP)
International Arctic Systems for Observing the Atmosphere
IASOA

INTERNATIONAL POLAR YEAR
2007-2008

Summer School Agenda

<u>Monday July 11, 2011</u>

Lectures will be held in Room 4 on the ground floor.

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 ready to leave at 10:00 AM.		
11:30 – 12:00	Arrive and check-in at Nottawasaga Inn (6015 Ontario 89, Alliston, ON)		
12:00 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 2:15	Welcome/ Lecture A	Kim Strong Emily McCullough	Introduction to the CREATE Training Program in Arctic Atmospheric Science and CANDAC/PEARL
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 4)		
4:15 – 5:00	Lecture B	Dylan Jones	Modeling the impact of long-range transport of pollution on the Arctic troposphere (Part 1)
5:00 – 5:45	Lecture C	Markus Rex	Arctic ozone loss and climate (Part 1)
5:45 – 6:30	Lecture D	Matthew Hitchman	Stratospheric dynamics I: Planetary and synoptic waves, jets, sudden warmings, and the northern annular mode
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30	Welcoming “Icebreaker”	All attendees	Starlite Lounge (3rd floor) Sponsored by ABB Inc.

Tuesday July 12, 2011

Lectures will be held in Room 4 on the ground floor.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Taneil Uttal	The atmospheric component of Arctic climate change (clouds, aerosols, greenhouse gases and mesoscale circulation patterns)
9:45 – 10:30	Lecture B	Dylan Jones	Modeling the impact of long-range transport of pollution on the Arctic troposphere (Part 2)
10:30 – 11:00	Coffee break (Room 4)		
11:00 – 11:45	Lecture C	Ralf Staebler	Applied micrometeorology in the Arctic
11:45 – 12:30	Lecture D	Markus Rex	Arctic ozone loss and climate (Part 2)
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture E	Matthew Hitchman	Stratospheric dynamics II: ENSO, QBO, and SAO influences on the Arctic
3:45 – 4:15	Coffee break (Room 4)		
4:15 – 5:00	Lecture F	David Hik (remote lecture)	Big picture of Arctic science
5:00 – 5:45	Lecture G	David Hik (remote lecture)	Aspects of terrestrial ecosystem change in the Arctic (tree line, shrub line, tundra), particularly the relationship to climate and snow
5:45 – 6:30	Lecture H	Ashley Kilgour	CANDAC Education and Outreach Program
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30	Free time & optional outdoor recreational activity	All attendees	Outdoor sports (soccer, volleyball, ultimate frisbee)

Wednesday July 13, 2011

Lectures will be held in Room 4 on the ground floor.
Posters will be displayed in Room 5 from Wednesday through Friday.
Poster boards will be set up on Wednesday morning and posters should be mounted during the morning coffee break.
Please stay near your poster for your assigned session:
Session A → 11:00 – 11:30 AM, Session B → 11:30 – 12:00 PM, Session C → 12:00 – 12:30 PM
Note that awards will be given to the best posters. Judges will be visiting during your assigned session.
The bus to CARE departs at 2:00 PM – please meet in the front lobby.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	James Drummond	CAPSNet proposal and CHARS as the future of Arctic Science
9:45 – 10:30	Lecture B	Taneil Uttal	The importance of long-term Arctic weather station data for setting the research stage for climate change studies
10:30 – 11:00	Coffee break (Room 5)		
11:00 – 12:30	Posters	All students	Student poster session
12:30 – 1:30	Lunch	Trainees' Advisory Committee members	CREATE Trainees' Advisory Committee meeting
2:00 – 5:00	Field Trip to CARE	Sandy Benetti	Tour of Environment Canada's Centre for Atmospheric Research Experiments at Egbert: Atmospheric research on air quality, climatology and meteorology
5:00 – 6:30	Free time		
6:30	Dinner (Riverview Dining Room) *Please note the earlier dinner time.		
8:30	Free time & optional indoor recreational activity	All attendees	Indoor mini-putt, billiards, ping-pong, and arcade games

Trainees' Advisory Committee Members
Cristen Adams (Secretary)
David Daou
Felicia Kolonjari
Zen Mariani
Emily McCullough (Chair)
Chris Perro

Thursday July 14, 2011

Lectures will be held in Room 4 on the ground floor.
Posters will be displayed in Room 5 from Wednesday through Friday.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Ralf Staebler	Tropospheric ozone depletion research
9:45 – 10:30	Lecture B	Matthew Hitchman	Stratospheric dynamics III: Global change and jet migration
10:30 – 11:00	Coffee break (Room 5)		
11:00 – 12:30	Lecture C	Peter Calamai	Seven sins of scientists communicating science
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture D	Pierre Fogal	Operating an Arctic research observatory
3:45 – 4:15	Coffee break (Room 5)		
4:15 – 5:00	Lecture E	Taneil Uttal	The International Arctic System for Observing the Atmosphere (A legacy project of the IPY)
5:00 – 5:45	Lecture F	James Drummond	A career in atmospheric science – one person's experience
5:45 – 6:30	Workshop	Ashley Kilgour	New outreach initiatives
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30	Free time		

Friday July 15, 2011

Lectures will be held in Room 4 on the ground floor.
Posters will be displayed in Room 5 from Wednesday through Friday.
Please check out by 11 AM; you may want to check out in the morning before lectures begin at 9 AM.
The front desk can store your luggage until departure.
Your poster must be removed before lunch on Friday.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Dylan Jones	Modeling the impact of long-range transport of pollution on the Arctic troposphere (Part 3)
9:45 – 10:30	Lecture B	James Drummond	Next stop – Mars (even colder and less hospitable)
10:30 – 11:00	Coffee break (Room 5)		
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.

Organizers

Kimberly Strong
Ashley Kilgour

Speakers

(Kim Strong will introduce absent speakers)

Peter Calamai
James Drummond
Pierre Fogal
David Hik
Matthew Hitchman
Dylan Jones
Markus Rex
Ralf Staebler
Taneil Uttal

Students

1) Cristen Adams
2) Justin Bandoro
3) Chris Caldow
4) Kuo-Hsien (Michael) Chang
5) Lin Dan
6) Anthony Dineen
7) Zoya Dobrusin
8) Marine Favier
9) Jonathan Franklin
10) Anya Gawor
11) Melissa Gervais
12) Liviu Ivanescu
13) Jaya Khanna
14) Jenny Kliever
15) Felicia Kolonjari
16) Sam Kristoffersen
17) Kristina Luus
18) Zen Mariani
19) Michael Maurice
20) Emily McCullough
21) Joseph Mendonca
22) Colleen Mortimer
23) Boris Pavlovic
24) Anne Wang Petersen
25) Camille Pagniello
26) Chris Perro
27) Niall Ryan
28) Patrick Sheese
29) Mehrnaz Sarrafzadeh
30) Majbritt W. Sørensen
31) Heidi Villadsen
32) Dan Weaver
33) Adrienne White
34) Robin Wing
35) Jun Yang

2011 NSERC CREATE Summer School in Arctic Atmospheric Science

Welcoming "Icebreaker"

Thank-you to our sponsor for this event

Starlite Lounge
Nottawasaga Inn, Alliston, Ontario
8:30 PM onwards, July 11, 2011

http://www.abb.ca/

Nottawasaga Inn Facilities

6015 Highway 89, Alliston, Ontario, Canada L9R 1A4 • Local: (705) 435-5501 • Fax: (705) 435-5840
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Squash & racquetball courts
Fully equipped fitness centre
Sauna & whirlpool
(Available during scheduled times. Age and ability restrictions may apply.)

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Outdoor pool with patio sundeck
Bocce courts
Volleyball
Horseshoes
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Private Golf Lessons (C.P.G.A. Certified Instructors)
(Call Main Pro Shop for rates & tee-off times - 705-435-5504)

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(coin operated)

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($10./hr/court - non prime time or $15./hr/court - prime time)

Aerobics, Aquafit, Fitness classes, Private Lessons
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($65/45mins, $79/60mins, $120/90mins)

Esthetician - (705) 435-8829

Hair Salon - (705) 435-4570

Starlite Lounge
Monday to Saturday 3pm - 12am
Sunday 4pm - 11pm

Located on 3rd floor, East wing

Gift Shop
Monday - Friday: 9:00am - 9:00pm
Saturday: 8:00am - 9:00pm
Sunday: 8:00am - 7:00pm
(hours may vary depending on season)

Sports & Leisure Dome
Hours of operation
Monday to Thursday
Facility: 6:00am - 11:00pm
Fitness Club: 6:00am - 10:00pm
Pool & Sauna: 7:00am - 9:30pm
Waterslide*: 8:00pm - 9:00pm
Friday
Facility: 6:00am - 11:00pm
Fitness Club: 6:00am - 10:00pm
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*: 9:30am - 12:00pm, 1:00pm - 5:00 pm, 6:30pm - 9:30pm
Sunday
Facility: 9:00am - 9:00pm
Fitness Club/Pool& Sauna: 9:00am - 8:00pm
Waterslide*: 9:30am - 12:00pm, 1:00pm - 5:00 pm, 6:30pm - 7:30pm
*Hours of operation subject to change without notice.

Riverview Dining Room
Continental Breakfast: 6:45am - 10am
Breakfast Buffet 7:00am - 10:00am
Lunch Buffet 11:30am - 1:30pm
Sunday Brunch 10:30am - 1:30pm

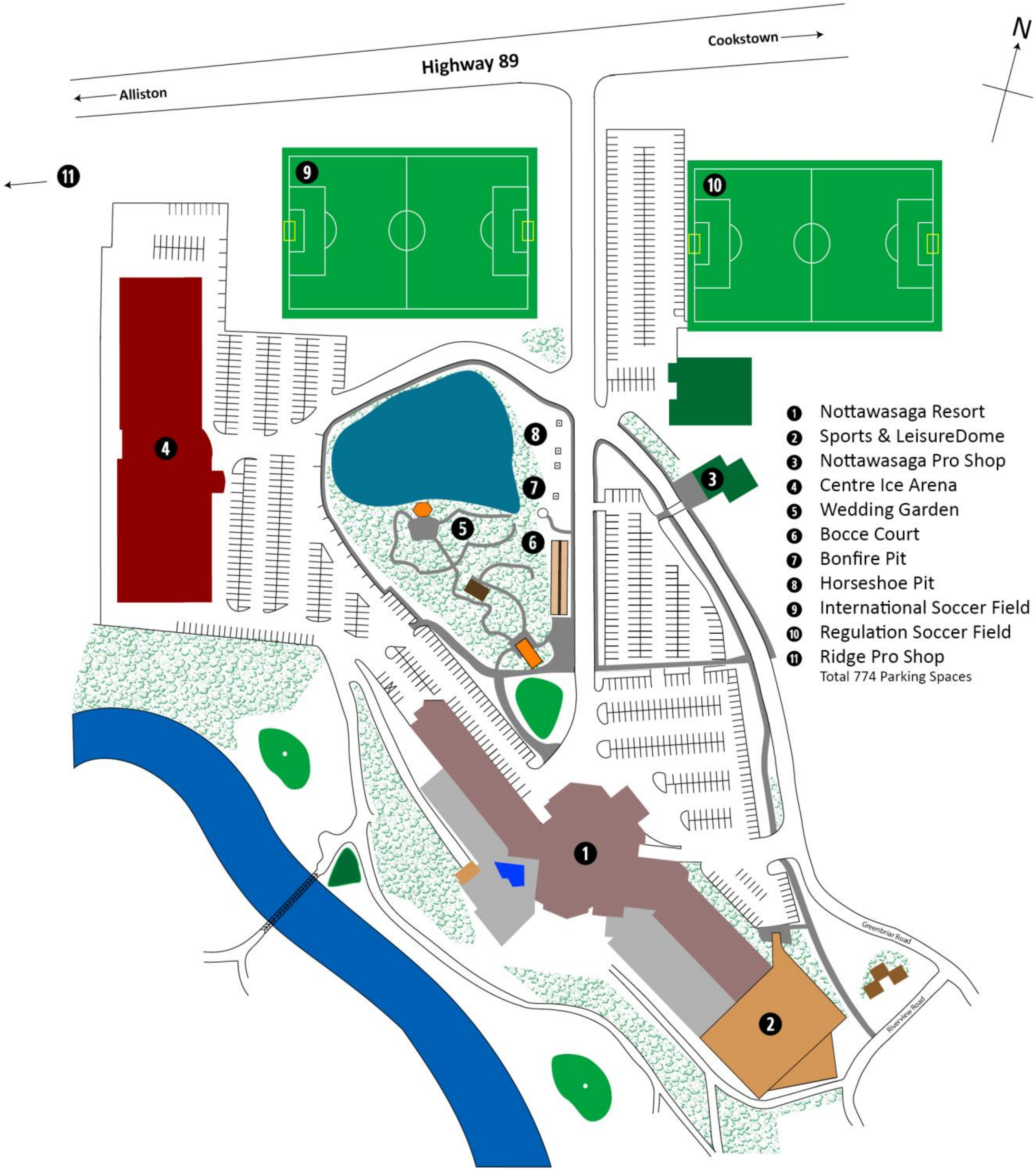
Dinner (Table d'hôte)
Monday - Thursday 6:00pm - 9:30pm
Friday & Saturday: 5:30pm - 9:30pm
Sunday: 5:30pm - 9:00pm
A buffet dinner may be substituted for menu options during certain holiday periods.

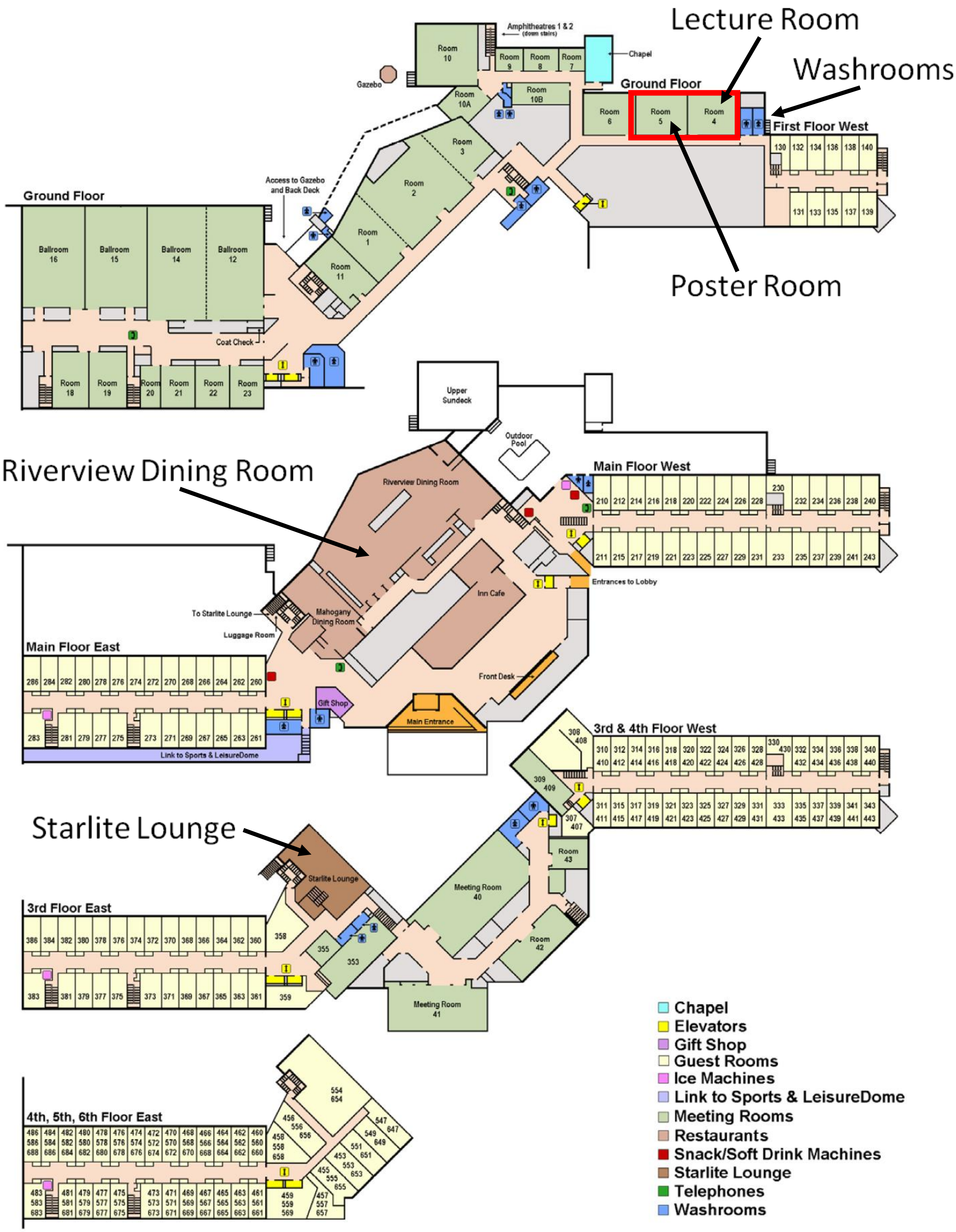
Mahogany Room
Monday to Thursday
6:00pm - 9:30pm
Friday & Saturday
5:30pm - 9:30pm
Closed Sundays & Holidays
*Smart-Casual Dress Code in effect for Mahogany Dining Room

Inn Café
Monday - Thursday: 10:00am - 10:00pm
Friday: 10:00am - 11:00am
Saturday: 10:00am - 12:00am
Sunday: 9:00am - 10:00pm
Buffet Dinner Friday and Saturday: 5:.30pm - 9:30 pm
(Buffet Dinner served Monday to Saturday in July and August only)
(buffet not served during holidays where buffet dinner is available in the Riverview Dining Room)

All interior areas of the Hotel are Non-Smoking.

Nottawasaga Maps

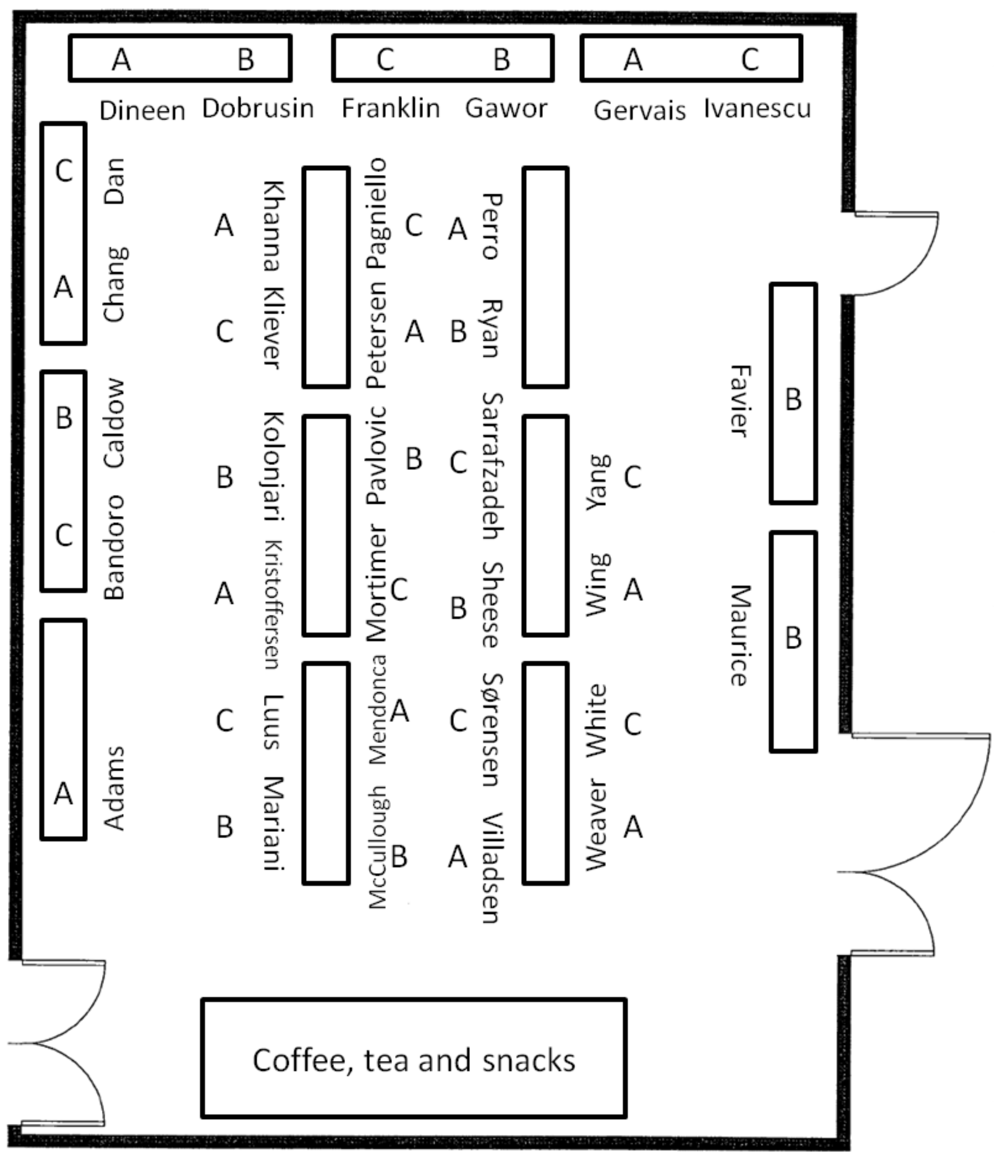




Lecture Room
Washrooms
Poster Room
Ground Floor
First Floor West
Room 4
Room 5
Room 6
Chapel
Amphitheatres 1 & 2 (down stairs)
Gazebo
Access to Gazebo and Back Deck
Ballroom 16
Ballroom 15
Ballroom 14
Ballroom 12
Coat Check
Riverview Dining Room
Mahogany Dining Room
Inn Cafe
To Starlite Lounge
Luggage Room
Main Floor East
Main Floor West
Upper Sundeck
Outdoor Pool
Entrances to Lobby
Front Desk
Gift Shop
Main Entrance
Link to Sports & LeisureDome
Starlite Lounge
3rd Floor East
3rd & 4th Floor West
Meeting Room 40
Meeting Room 41
Room 42
Room 43
4th, 5th, 6th Floor East
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 5 from Wednesday through Friday.
Poster boards will be set up on Wednesday morning. Please mount your posters in the locations indicated below during the Wednesday morning coffee break.
Poster boards will be set up on Wednesday morning and posters should be mounted during the morning coffee break.
Please stay near your poster for your assigned session:
Session A → 11:00 – 11:30 AM, Session B → 11:30 – 12:00 PM, Session C → 12:00 – 12:30 PM
Note that awards will be given to the best posters. Judges will be visiting during your assigned session.
Please take down your poster before lunch on Friday.



Room 5

POSTER ABSTRACTS

Ozone, NO_2, and OClO measured above PEARL during record ozone depletion in 2011

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The Arctic experienced a record ozone loss in Spring 2011. We will present an investigation of this event in the context of eleven years of measurements taken at the Polar Environment Atmospheric Research Laboratory (PEARL) by three UV-visible spectrometers from 1999-2011. OClO is clearly enhanced in 2011, indicating chlorine activation above PEARL. While OClO is elevated, both ozone and NO_2 measurements are lower than in any other year on record, suggesting ozone depletion and denitrification. These measurements will be evaluated in the context of the location of the polar vortex and other dynamical parameters.

Results from the Second ISSI Meeting for NDACC Lidars in Bern

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Atmospheric lidars rely on the scattering and absorption of the emitted light from a laser with atmospheric particles. From the backscattered light many properties of the atmosphere, including temperature, aerosols, clouds, and species concentrations can be measured. An integral part in the determination of these measurements is the lidar data analysis software, specifically where the noisy data is filtered and smoothed. For example, when temperature and ozone concentration profiles are retrieved over a night, there is a vertical resolution associated with the filtering of the data. However, there is no unique definition of vertical resolution, as it can be reported in many different ways and presently very difficult to compare what is reported between two different lidars.

In order to standardize the reporting of vertical resolution for temperature and ozone profiles, the Network for Detection of Atmospheric Composition Change (NDACC) held a conference at the International Space Science Institute (ISSI) in Bern, Switzerland from June 13th to 17th, 2011. A team of six lidar experts from around the world took part. Prior to the meeting, a set of vertical resolution tools were developed to be incorporated into lidar data analysis software so that all NDACC lidars could consistently report vertical resolution. Before this could be implemented, a lidar simulation program was used to create raw data from an existing temperature profile. This simulated data was then inputted into each lidar station’s own data analysis software to verify that their respective algorithm worked correctly and that the temperature profiles are in agreement. To achieve this, any systematic errors which were introduced in lidar algorithms needed to be eliminated such that all lidars could implement the vertical resolution tools without bias.

All of these goals were accomplished for all the temperature lidars at the meeting with positive results of the simulated versus retrieved temperatures profiles. The vertical resolution tools were then placed in the data software and simulated data from a noisy temperature profile was digitally filtered. However, full testing of the vertical resolution tools was not completed for all of the temperature lidars at the meeting and the work is still in progress.

I Thought You Were Passive But You Keep Emitting Greenhouse Gases! Measuring Greenhouse Gas Exchange between Inland Waters and the Atmosphere

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The emissions of greenhouse gases from inland waters (e.g. rivers, streams, reservoirs, lakes, ponds, wetlands) are indeed significant and are comparable in quantity to the net uptake of anthropogenic carbon dioxide emissions by the terrestrial biosphere or the oceans (Bastviken et al., 2011). These emissions, however, have been neglected in terms of their inclusion in the 'conventional' carbon cycle (e.g. Intergovernmental Panel on Climate Change (IPCC) Assessment Report Four (AR4); Denman et al., 2007). Furthermore, emission estimates are not adequately constrained by measurements and as such are often quoted as conservative values, particularly for CH4 and N2O which have received far less attention than CO2.

The focus of my PhD research is the in-situ measurement of greenhouse gas exchange between inland waters and the atmosphere. The initial phase of the research will involve a six week measurement campaign on the Yenisei River (Siberia, Russia) where the flux will be derived using two different methods: (1) floating chambers, and (2) estimation of gas transfer velocity and measurement of gas partial pressures in the surface water as well as in the overlying atmosphere. Gas (CO2, CH4 , N2O, CO and δ13C (13C isotopic form of CO2)) concentrations will be measured using Fourier-Transform InfraRed (FTIR) Spectroscopy.

The campaign will be used to evaluate the measurement technique, and if successful, it will be applied to similar measurement campaigns in the tropical inland waters of northern Australia. The results will principally provide an estimate of the greenhouse gas exchange between the Yenisey River and the atmosphere. Additionally, there will be a multitude of other information that can be obtained through analysis of the results including assessment of mechanisms controlling the flux, quantification of contribution to the global greenhouse gas budget through combination with other flux estimates from inland waters, modeling how the gas exchange is expected to respond in future (e.g. climate change feedbacks) and biogeochemical assessment of the river.

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Modeling Carbon Dynamics in Agriculture and Forest Ecosystems Using Process-based Models – DayCENT and CN-CLASS

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Future climate change will be influenced significantly by the organic carbon dynamics in agricultural and forest soils, because the massive amounts present in carbon pools are susceptible to increased net mineralization due to soil disturbance and respiratory loss by soil organisms. To quantify the effects of agricultural management and component respiration on the carbon budget, the daily version of the CENTURY (DayCENT) model and the Carbon and Nitrogen coupled Canadian Land Surface Scheme (CN-CLASS) model were employed. Based on substantial field measurements for quantifying the carbon budget in terms of plant carbon allocation, net ecosystem production, component respiration and soil organic carbon (SOC) at daily and half-hourly time-steps, both models were examined for their ability to predict the effects of agricultural management and phenology on carbon dynamics. Our study sites were located at the University of Guelph Elora Research Station and the Borden Forest Research Station, southern Ontario, Canada.

Effects of conventional tillage (CT) and no-till (NT) practices on carbon dynamics in a cropfield was modeled by application of a 5000 year equilibrium simulation to ensure the development of steady-state and representative SOC pools, followed by a 9-year simulation of agricultural management practices. The effects of phenology on multi-year transformation of litterfall and SOC, and the potential for carbon sequestration were quantified. During our initial studies, we found that the plant phenology algorithms used in CN-CLASS were not fully constructed, resulting in a high uncertainty in the simulations. Using the DayCENT agricultural simulation, a new agricultural module for CN-CLASS was designed and tested. Furthermore, to quantify the respiratory losses in deciduous forests using CN-CLASS, we examined the dynamics of component respiration in comparison with vegetation growth and further traced the contribution of soil respiration sources from litterfall, SOC and root respiration.

In summary, phenology played a fundamental role in regulating the carbon inflow/outflow dynamics in both agricultural and forest ecosystems. A flexible crop-specific phenological algorithm is required to mitigate the uncertainty of carbon budgets in land surface models. At the agricultural site, the total carbon sink during the growing season is estimated as 477.5 g C m−2. CT enhanced the SOC decomposition relative to NT by 38.4, 93.7 and 64.2 g C m−2 yr−1 for corn, soybean and winter wheat crops, respectively. The annual variation of the total SOC pool was greater in CT than NT due to tillage effects on carbon transfer from the active surface SOC pool to the active soil SOC pool at a rate of 50–100 g C m−2 yr−1. The adoption of NT accounted for a 10.7 g C m−2 yr−1 increase in the slow SOC pool. At the deciduous forest site, the total ecosystem CO_2 emission was estimated at 1366 g C m−2, that mainly due to heterotrophic respiration (57%) and maintenance respiration (37%). Annual soil respiration was estimated as 782 g C m−2, which was mainly from the SOC pools (60%).

PARIS-IR at 2011 ACE Arctic Validation Campaign

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The Portable Atmospheric Research Interferometric Spectrometer for the Infrared (PARIS-IR) is a Fourier Transform Spectrometer (FTS) with a spectral resolution of 0.02 cm^{-1} that measures the spectral region from 750–4400 cm^{-1} simultaneously within about 6.6 minutes for one measurement. PARIS-IR is one of the ground-based instruments used for the Canadian Arctic Atmospheric Chemistry Experiment (ACE) Validation Campaign Project.

ACE is a satellite mission for remote sensing of the Earth's atmosphere on board the Canadian satellite SCISAT-1, which was launched on 12 Aug. 2003. It orbits the Earth at an altitude of 650 km. There are two instruments on board the satellite: ACE-FTS with resolution of 0.02 cm^{-1} range from 750–4400 cm^{-1}; MAESTRO with dual optical spectrophotometer covering the 285-1030 nm spectral range with a resolution of 1-2 nm. It is crucial to test a satellite instrument's accuracy, reliability and consistency as it ages, and PARIS-IR contributes to validating the ACE-FTS instrument.

During each spring since 2004, the ACE occultations are over the high Arctic. At the same time the polar vortex is formed and air is isolated within it over the North Pole, when the stratospheric temperatures are below-78°C, polar stratospheric clouds (PCS) can be formed through the long Arctic winter. When the sun comes up in spring, the chemical processes will change both the concentrations and distributions of different species in the Arctic atmosphere.
During 2011 spring, PARIS-IR took part in the Canadian Arctic ACE Validation Campaign Project from February 18 to April 4 at Polar Environment Atmospheric Research Laboratory (PEARL), which is 86°25'W, 80°3'N, 610m above the sea level, and 15 km from the Eureka Weather Station. PARIS-IR recorded 845 atmospheric measurements in 22 days, and from these total columns of O_3, HNO_3, HCl and HF have been obtained.

Development of a balloon-borne imager for observations of aerosols in the upper troposphere lower stratosphere region

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LIMA (Limb Imaging of Aerosols) is a four channel, balloon mounted radiometer being developed to observe solar scattered radiances at 355 nm, 532 nm, 1064 nm, and 1500 nm. The objective will be to observe and study thin aerosol layers, polarization properties, the colour ratios, and the spatial and temporal variation of aerosols at altitudes between 10~40 km. These observations, in conjunction with those taken from other instruments, will be used to measure the radiative budget of the region as an indication of climate change in the middle atmosphere. In March 2010 a proto-type version of the instrument, taking measurements in the 355 nm and 532 nm wavelength regions, was flown over Southern India. Orientation was provided by a pair of magnetometers and GPS provided the measurement of the position, velocity, and altitude. Analysis of the data provided by this test flight was used to help determine improvements necessary for the next iteration of the imager. At this moment development is being undertaken on the design of a baffling system to reduce upward scattered radiances and limit saturation of the CCDs.

Product Yield Measurements for the Reaction of Beta-Pinene with HO Radical Using Mass Spectrometry

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Beta-pinene is an important biogenic volatile organic compound (VOC). The oxidation of VOCs has been found to form semi-volatile products that have the ability to partition between the gas and particle phase. In the particle phase they can contribute to a significant amount of the organic component of particulate matter (PM). Processes that contribute to PM are of interest since PM has been linked to cardiovascular ailments, reduced visibility and climate change. However, the products that result from VOC oxidation and the mechanisms by which they contribute to PM are not fully understood.

In our group, the York University smog chamber is being used to study the products resulting from the reaction of the hydroxyl radical (HO) with beta-pinene. While chamber output analyzed by APCI-MS/MS (atmospheric pressure chemical ionization tandem mass spectrometry) is currently used in on-line, beta-pinene product identification; it is also advantageous to gain quantitative information using the same instrument. Quantitative information will allow us to calculate product yields that pertain to our experimental conditions, potentially obtain product distributions in both the gas and particle phase and gain a better understanding of the instrument's sensitivity toward different classes of compounds.

In my project so far I had tested a set-up in order to calibrate for one of the major gas phase b-pinene products (nopinone) as well as addressed some of the problems that pertain to the instrument's poor dynamic rage over broad concentration ranges. Product yield values for nopinone obtained for my experimental conditions had an average value of 25%, which falls into the range of 17-30%, reported in the majority of previous literature studies. In the future I hope to use the set-up and knowledge gained from the nopinone experiments to calibrate for other products of the reaction.

Interferometer Optical System and PEARL Imager Data Analysis

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Two of the optical instruments at the Polar Environment Atmospheric Research Laboratory (PEARL) are the E-Region Wind interferometer and the PEARL All-Sky Imager. Research into the optical system design of the interferometer using ZEMAX and the analysis of data from the imager are being undertaken. The imager measures gravity wave signatures and work on determining the properties of these waves is being undertaken. The details of the optical system of the interferometer will be described and the analysis of the wave signatures summarized.

FTS and Sun Tracker Development at Dalhousie University

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We have installed a newly refurbished high resolution Fourier Transform Spectrometer (FTS) at the Dalhousie Atmospheric Observatory (DAO) located on the Dalhousie University campus, Halifax, Nova Scotia. The instrument, an ABB Bomem DA8, has undergone substantial upgrades to the electronics and software and has been making semi-autonomous solar absorption measurements since April of 2011 with a primary goal of monitoring the chemical composition of the pollution outflow from Northeast North America.

The DA8 is owned by the Canadian Space Agency, while the modifications have been performed at Dalhousie University. Physical changes include the replacement of the original 16-bit digitizer with a new 18-bit model, thus avoiding the need for an undesirable gain switch during scans. New fully scriptable control software has been written using National Instruments LabVIEW software and provides great transparency and control over the analysis of the data by treating each scan independently.

A newly designed altitude/azimuth sun tracker built to support the DA8 has been operating successfully at DAO since June 2010. The primary tracking algorithm is based on ephemeris calculations thereby minimizing the effects of a temporary loss of signal due to a passing cloud. This passive mode is supplemented by an active correction routine whereby a small portion of the solar beam is directed to a camera. Careful monitoring of the solar disc's position enables corrections to be made to the tracking as well as providing a quantitative measure of the tracking accuracy as a function of time.

This summer the DAO DA8 will be taking part in its first major campaign by providing ground based measurements of biomass burning outflows for the BORTAS mission (Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites). The co-location of many ground based instruments for this campaign will provide ample opportunities for instrument validation.

Trends of Legacy and Current Use Pesticides in Canadian Arctic Air and Water: 1999-2010

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Whereas the use of most organochlorine pesticides (OCPs) has been banned, other insecticides, fungicides and herbicides, also referred to as current use pesticides (CUPs), continue to be applied. Transport of pesticides from agricultural fields to non-target areas is not only of interest because of the potential effect on non-target organisms and ecosystems, but also because their occurrence in remote regions is recognized as evidence for long-range transport under international protocols, which were implemented to control persistent, bioaccumulative, and toxic substances. Some OCPs and CUPs ultimately make their way to the Canadian Arctic, where they have previously been detected in air, water, ice, and biotic species. Due to colder conditions, they can persist in the Arctic environment for longer periods of time. Establishing temporal and spatial trends of the occurrence of these contaminants is essential in order to understand the effect that these contaminants will have on the environment; especially since the diminishing Arctic sea-ice due to warming temperatures may change the mobility of the chemicals in the environment. Air and water samples were collected as part of several campaigns (Tundra North-west-99, the International Polar Year 2007-2008 and ArcticNet-2010) to determine the occurrence and levels of OCPs and CUPs over time. OCPs and CUPs found during ArcticNet-2010 include: hexachlorocyclohexanes (HCHs), chlordanes, dieldrin, toxaphene, dacthal, endosulfans, chlorothalonil, chlorpyrifos and trifluralin. When compared to 1999 and 2007/08, OCP concentrations have been declining in Canadian Archipelago water, whereas CUP concentrations, especially for endosulfan and chlorothalonil have increased significantly in Arctic water.

Understanding the Impacts of Future Sea Ice Decline on Atmospheric Circulation, Storm Tracks, and Precipitation

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Sea ice in the Arctic is expected to decline in the future, eventually becoming purely seasonal in the 2100's. This sea ice loss may cause significant changes in the atmospheric circulation, storm tracks, and precipitation. The prediction of these changes is complicated by the uncertainty in our knowledge of the patterns of sea ice reduction that will occur during the transition to seasonal ice cover. The main goal of this project is to understand how changes in sea ice, both in the transient phase and in the purely seasonal ice cover phase, will impact the atmospheric circulation, storm tracks, and precipitation. For the transient phase, this will involve understanding how changes in sea ice in different sectors of the Arctic impact the atmosphere individually, to create the full signal that the various patterns of transient sea ice loss have on the atmosphere. These two phases of sea ice loss will be studied using the Community Atmosphere Model Version 3, with specified sea ice and sea surface temperature boundary forcing. In examining the precipitation output, it is not just the averages that are important, but it is the extreme events that have the greatest socio-economic impacts. Before we can examine the changes in precipitation events that reduced sea ice may induce, the ability of the model to reproduce the observed frequency and intensity of precipitation must be determined. This will be accomplished by examining the statistics of these values in model, reanalysis, and observational data. Results presented here will focus on the analysis of observational and reanalysis precipitation data to examine some of the errors that exist within these products, prior to comparisons with the model precipitation. This project will provide a more complete understanding of the impacts that changes in sea ice will have on the atmosphere. Furthermore, it will provide a better understanding of the ability of climate models to predict extreme precipitation events, which are of great importance to society. These are both vital in furthering of our ability to determine the changes in weather and climate that we might expect in a warming climate.

Star-photometers and Ground-based Lidars to evaluate Caliop during the Arctic night

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Caliop's expected performances were confirmed at mid-latitudes. It's useful however to evaluate its performances also in the extreme environment of the polar nights, particularly through thin ice clouds and near the ground. Two ground-based atmospheric observatories, PEARL, CA (80N, 86W) and Ny-Ålesund, NO (79N,12E), experience the most satellite overpasses. Lidars already operate at both locations, providing a better detection of the near the ground layers. In addition, state-of-the-art star-photometers, providing integrated extinction, were recently deployed. We propose here a method facilitating the comparison of instruments analyzing slightly different atmospheric layers. The statistics of the current star-photometer data is also provided.

Temperature retrieval from Lidar data using techniques of non-linear mathematical inversion

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The conventional method of Lidar data processing to retrieve atmospheric temperature profiles has some limitations, which necessitate the abandonment of the temperatures retrieved at the uppermost limits of the observational range. This happens because the mathematical implementation of the conventional method requires one to choose a `seed pressure' at the top of the atmosphere. An error or a wrong choice of seed pressure increases the uncertainty of the temperatures retrieved at the top of the observational range. The application of mathematical inversion, as a tool to remedy this problem, was investigated in this project. A simple grid search technique was used to develop an alternative way of retrieving atmospheric temperature profiles from Lidar data. Data obtained from the Purple Crow Lidar (PCL) (42.87° N, 81.38° W, 225 m) facility at the University of Western Ontario was used to perform the preliminary tests on this technique. PCL data for some nights of observation were processed by the new technique. Initial results show that data at the uppermost altitude limits can be reliably retrieved with this method. A numerical scheme to analyze errors in the retrieved temperatures was developed. The uncertainties in retrieved temperatures computed using this method are comparable to the corresponding uncertainties in the conventional technique.

Setup of the Suntracker for the Portable Atmospheric Interferometric Spectrometer for the Infrared in preparation for the BORTAS campaign

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Changes to the Earth's atmosphere are cause for concern and have motivated atmospheric research campaigns in many regions around the world. For the upcoming BORTAS (Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites) campaign, the Portable Atmospheric Interferometric Spectrometer for the Infrared (PARIS-IR) will be located at Dalhousie University. PARIS-IR is a high resolution (0.02cm^{-1}) infrared (750-4400cm^{-1}) Fourier Transform Spectrometer that records solar absorption spectra of atmospheric trace gases. In order to take measurements, an instrument called a Suntracker is used to direct the sunlight into PARIS-IR. The Suntracker will be installed on the roof of the Physics and Atmospheric Physics Department building at Dalhousie University. This instrument tracks the Sun such that the beam of sunlight is optimally centered on the optical window of PARIS-IR throughout the measurement day (sunrise to sunset). With this setup, PARIS-IR will be taking measurements during the BORTAS campaign. The data will be processed at the University of Toronto to provide total column amounts of atmospheric constituents such as O_3, CH_4 and others.

Measurements of HCFC-22 using the Atmospheric Chemistry Experiment Fourier transform spectrometer

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In the 1980s scientists discovered an annual springtime minimum in stratospheric ozone over the Antarctic. It was determined that the decline in ozone concentration was primarily caused by catalytic reactions of ozone and atomic chlorine. The emissions of anthropogenic chlorofluorocarbons (CFCs) were determined to be major sources. The Montreal Protocol on Substances that Deplete the Ozone Layer (with its subsequent amendments) restricts the emissions of ozone depleting substances. To fulfill the need for safe, stable replacements of CFCs, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) were developed.

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). With its wide spectral range, the ACE-FTS is capable of measuring a extensive range of gases including key CFC and HCFC species. The height information from the ACE-FTS profiles provides information that is complementary to the ground-based sampling that has been used to monitor these species. Measurements of the global distribution of HCFC-22 including comparisons to ground-based and air-borne measurements will be presented.

ERWIN-II: Algorithm Descriptions, Wind Results, and Meteor Radar Comparisons

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The E-Region Wind Interferometer (ERWIN-II) is a Michelson interferometer that measures mesospheric winds (~90 km) by determining Doppler shift in the greenline (557.7 nm), O_2 (866.0 nm) and OH (843.0 nm) airglow emissions. Airglow is the emission of light by excited particles in the atmosphere. The phase change of the interferogram due to the Doppler shift of the airglow emission is determined using a least-mean squares approach using the gradient and Hessian matrix of the Michelson intensity, visibility and phase. The technique used to convert the phase to wind, horizontal and vertical wind results from January 2009, and comparisons with the meteor radar will be presented. The meteor radar determines winds in the mesosphere with a height resolution of 3 km. Thus, the comparisons of ERWIN winds to meteor radar winds allow for the validation of both instruments, as well as, the estimation of the emission layer heights.

Estimating the influence of snow on net ecosystem exchange

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Although a majority of biospheric CO_2 flux in Arctic regions occurs during the snow season, models of net ecosystem exchange (NEE) have tended to include only growing season processes and parameters. The objective of this study was therefore to examine the influence of snow depth on NEE, and explore the potential to incorporate remotely sensed estimates of the quantity of snow in order to reduce uncertainty in model estimates of NEE. Snow season NEE is driven by soil temperature and nutrient availability. As snow depth increases during the snow season, air temperature and soil temperature become decoupled, complicating efforts to estimate snow season NEE as a function of air temperature. The objectives of this research were therefore to assess: 1) the influence of snow depth on snow season NEE at three Canadian Carbon Program study sites (AB Western Peatland, QC Black Spruce Cutover and ON Boreal Mixedwood); and 2) the potential for improving estimates of snow season NEE using air temperature and snow depth as a proxy for soil temperature. Statistical analysis of snow season CO_2 flux, temperature and snow depth were conducted using exploratory and multiple regression analyses. Linear increases in soil temperature were found to be associated with exponential rises in soil respiration. A modified Q10 function can be used to explain a significant portion of the variability in NEE as a function of air temperature, with little between site variation in regression parameters. It may therefore be possible to generalize relationships between subnivean respiration, air temperature and snow depth in order to improve estimates of snow season NEE.

Since completion of this project in December 2010, research has focused on assessing the influence of snow cover area on NEE upon snowmelt at a site in the Canadian low Arctic. Remotely sensed observations of snow cover area and snow water equivalent are now being incorporated into the Vegetation Photosynthesis and Respiration Model (VPRM), and their influence on uncertainty in model estimates of NEE is being assessed.

Radiation and Trace Gas Climatologies in the High Arctic using the Extended-range Atmospheric Emitted Radiance Interferometer

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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. The SFIT2 retrieval code, which is widely used in the infrared (IR) community, has recently been modified so it can be used on IR emission spectra, such as those produced by the E-AERI. Total columns of trace gas species including ozone, carbon monoxide, and nitrous oxide total columns have been retrieved year-round. This allows the identification and quantification of chemical ozone loss at Eureka during each Arctic winter-spring, as well as the monitoring of other trace gases. 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. The instrument was then moved to the Zero-altitude PEARL Auxiliary Laboratory (0PAL) where it has been taking measurements since.

Measurements are taken every seven minutes year-round, including polar night when the solar-viewing FTIR spectrometers at PEARL are not operated. Comparisons of radiance measurements between the E-AERI and a similar instrument, the University of Idaho's Polar Atmospheric Emitted Radiance Interferometer (P-AERI), which was installed at 0PAL from March 2006 to June 2009, agree within $\pm$ 1 mW/(m^2 sr cm^{-1}) up to 1800 cm^{-1} and $\pm$ 0.2 mW/(m^2 sr cm^{-1}) from 1800-3000 cm^{-1}. A fast line-by-line radiative transfer model is used to simulate the downwelling radiance at both instruments' altitudes. Simulated and measured radiances agree within $\pm$ 20 mW/(m^2 sr cm^{-1}) up to 1800 cm^{-1} and $\pm$ 1 mW/(m^2 sr cm^{-1}) from 1800-3000 cm^{-1}. Measurements from these two instruments will be used to study the impact of clouds, water vapour, ice crystals, etc., on the radiative budget. For instance, the influence of clouds on the E-AERI's radiances are shown to increase in the 400-600 cm^{-1} and 750-1400 cm^{-1} regions when clouds are present as verified by the Millimeter Wave Cloud Radar, which is also stationed at 0PAL.

CANDAC Outreach Project: Student-Researchers Atmospheric Collaboration

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The Canadian Network for the Detection of Atmospheric Change (CANDAC) is a group of university researchers who strive to improve the state of observational atmosphere research and education in Canada. Our team has been measuring the Arctic atmosphere from the Polar Environment Atmospheric Research Laboratory (PEARL), located in Eureka, Nunavut, since 2005. The CANDAC outreach program provides students and researchers the opportunity to meet and then engage in relevant atmospheric science education. Our outreach team aims to help students make connections between the science curriculum they are learning and the research being conducted at PEARL and across Canada, and to gain an understanding of its relevance to their society and their environment. Hands-on activities, interactive demonstrations, and thought-provoking presentations have been effective modes for engaging students in a range of grades.

Since our school visits have been well-received by students and teachers in Nunavut and Southern Ontario, we decided to offer a new project concept that enabled students to become co-investigators in atmospheric research. Students at Qarmartalik School in Resolute Bay, Nunavut, and Pickering College in Newmarket, Ontario had the opportunity to gather data and conduct inquiry-based investigations about current atmospheric conditions using instruments located at their own school. The program aimed to meet the following goals: Provide students the opportunity to collect scientific data on their local environment with a focus on the atmosphere; allow students to share their ideas and collaborate with other students and scientists through the Internet and telecommunications; and promote dialogue about and understanding of atmospheric science and its contributions to global environmental issues.

A pilot project was launched at two schools and then assessed on its successes and areas of potential improvement. The results of the atmospheric measurement project will be discussed and displayed pictorially. A brief history of Resolute Bay, NU, as well as select pictures from the outreach trips in March and May 2011 will be presented to provide a more complete picture of education in the North.

Depolarization in clouds with the CANDAC Rayleigh-Mie-Raman Lidar

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During polar winter, in the absence of incoming solar radiation, clouds can dominate the radiation budget (Noel et al., 2006). It is essential to understand the radiative impact of various cloud types in order to produce a correct estimate of climate. Mixed-phase clouds are particularly complex as they involve interactions between three phases of water (vapour, liquid and ice) coexisting in the same cloud. There is still great uncertainty in the relative abundance of particles of each phase, in the morphology of solid particles, and in precipitation rates (Wang, 2006 and de Boer and Eloranta, 2006). The atmospheric radiation balance is particularly sensitive to cloud particle phase as liquid and solid cloud phases usually have different scattering properties. LIDAR (light detection and ranging) is ideally suited to parametrize the cloud optical properties in terms of liquid and ice water content, particularly during polar winter, as measurements do not depend upon sunlight.

The Canadian Network for the Detection of Atmospheric Change (CANDAC) Rayleigh-Mie-Raman Lidar (CRL) was installed in the Canadian High Arctic at Eureka, Nunavut (80°N, 86°W) in 2008-2009. The remotely-operated system began with measurement capabilities for multi-wavelength aerosol extinction, water vapour mixing ratio, and tropospheric temperature profiles, as well as particulate density and colour ratio. In 2010, a new depolarization channel was added. The term “depolarization” describes the extent to which the polarization state of the lidar beam is changed by scattering interactions with cloud particles in the sky. Measuring the polarization state of the returned beam provides the ability to discern between ice crystal, liquid water, and aerosol returns.

Many depolarization-capable lidar systems use two separate detector channels: one for the component of the backscattered lidar return which is parallel to the transmitted laser light, and one for the component which is perpendicular. The CRL, instead, uses a rotating Glan-Thompson prism to allow perpendicular and parallel light through to a single PMT on alternate laser shots. This approach simplifies the calibration of the depolarization measurements because no corrections are needed to account for differences in sensitivity of two physically separate measurement channels. Details of the CRL depolarization channel and some first results will be discussed.

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Comparison of CH_4 retrieved from mid-infrared spectra (using different retrieval strategies) with CH4 retrieved from near-infrared spectra measured at Eureka

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Methane (CH_4) is a very potent greenhouse gas in the Earth's atmosphere, with a global warming potential of 25 over 100 years. As the average global temperature increases, methane in the arctic trapped in permafrost is released into the atmosphere. Precise measurements of methane are crucial for the validation of satellite measurements and implementation into models, so that policy makers receive the most accurate data when making decisions.

The Total Carbon Column Observing Network (TCCON) is a network of Fourier transform spectrometers (FTSs) that use a non-linear least squares spectral algorithm (called GFIT), for the analysis of solar spectra. From these spectra, one can retrieve precise amounts of column-averaged abundances of methane. The Bruker IFS 125HR FTIR at the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka has been making TCCON near-infrared (NIR) measurements since September 2009 and mid-infrared (MIR) since 2006. So methane measurements from both NIR and MIR spectra overlap since September of 2009.

In order to retrieve accurate amounts of column-averaged abundances of methane from MIR spectra, multiple retrieval strategies were studied and compared to TCCON NIR measurements using the 2010 data set. The first strategy uses the original volume mixing ratio (VMR) a priori (initial guess) profiles developed for analysis of Eureka MIR spectra, while the second strategy uses a priori profiles derived from the WACCM atmospheric model. The third and fourth strategies are outlined in Sussman et al. (2011). These two strategies involve retrieving methane with different line lists and select microwindows in conjunction with applying the inverse Tikhonov matrix when performing the retrievals. The retrieval algorithm used in all the MIR strategies is SFIT2, which is an optimal estimation retrieval algorithm. This poster will present a summary of the methane MIR and NIR analyses and comparisons performed to date.

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Stability and recent changes of the Milne Ice Shelf, Ellesmere Island, Nunavut, 1950 – 2009

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This study presents a comprehensive assessment of the current state of the 205 km^2 Milne Ice Shelf and how it has changed over the last 59 years. Present day ice thickness (2008/2009) determined from ground penetrating radar profiles was compared to those obtained from a 1981 airborne radio echo sounding survey, providing the first direct measurement of thinning for any Northern Ellesmere Ice Shelf. Ice shelf area was determined from air photo mosaics (1950, 1959, 1974, 1984) and satellite imagery (ERS-1, ASTER, RADARSAT-1). Results show an average thinning of 8.0 ±2.4 m with maximum thinning over the last 28 years of >30 m. Reductions in areal extent (29%, 82 ±0.8 km^2: 1950 - 2009) and volume (16%, 1.9 ±0.6 km^3 water equivalent (w.e.): 1981 - 2009) indicate that the Milne Ice Shelf has been in a state of negative mass balance for at least the last 59 years.

Accumulation from factors such as precipitation, basal accretion, and glacier input have not balanced losses due to calving, surface and basal melt, and glacier retreat. A comparison of mean annual specific mass balance measurements with the nearby Ward Hunt Ice Shelf (WHIS) suggests that basal melt is a key contributor to ice shelf thinning. A large area at the rear of the ice shelf transitioned from ice shelf ice to lake ice and glacier inputs to the ice shelf have reduced over the study period. The development and expansion of new and existing surface cracks indicate substantial ice shelf weakening. Given projected increases in mean annual air temperature, together with the factors listed above, the deterioration of the *pre-weakened* Milne Ice Shelf will almost certainly continue in the future.

Receiver Field of View Characterization of the CANDAC Rayleigh-Mie-Raman Lidar

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The CANDAC Rayleigh-Mie-Raman Lidar (CRL) at Eureka, Nunavut (80N, 86W) has been successfully used to measure aerosols and water vapour over the past three years. The field of view (FOV) of the telescope and the lasers alignment to the FOV have a dramatic affect on the overall performance of the lidar. This investigation will attempt to characterize this relationship in two ways. First, the entire FOV of the telescope will be mapped, as this will provide further information about the alignment of the laser beam for a range of FOVs and thus, determine the affect of the FOV on the optimal alignment. Second, simulations to determine the theoretical change in the background signal received and its relationship to the FOV were done in order to compare it to the experimentally determined relationship. The procedures, control software, visualization methods, and preliminary results will be presented.

Intercomparissons of Ground-Based and Satellite Measurements of O_3 and NO_2 above PEARL research station, Eureka Nunavut, from 2003 to present

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Arctic O_3 exhibits high seasonal variability. Atmospheric densities of the gas are dependent on a complex and delicate system of atmospheric dynamics. Among the constituents of the system, trace gases play an important role. NO_2 is a trace gas involved in catalytic ozone depletion cycles in the upper stratosphere, while it prevents spring-time ozone depletion in the lower stratosphere. As a short-lived gas, stratospheric NO_2's concentration is highly dependent on available sunlight, which also greatly varies seasonally in the Arctic.

This is the basis for the study on the intercomparisons of ground-based and satellite NO_2 and O_3. This work will focus on the assembly of partial columns for these species over Eureka, Nunavut, and more specifically the Polar Environment Atmospheric Research Laboratory, PEARL (80.05°N, 86.42°W). The O_3 partial columns will be calculated in the 0 to 52 km altitude range, with ozonesonde data used for the 0 to 14 km altitude range for all satellite data sets (below 14km satellite data is rejected). For NO_2 the altitude range will be 16 to 40 km, with expansion from 10 to 60 km using the photochemical box model. The data for this work is retrieved from both ACE FTS (version 2.2, 2.2 Ozone Update, and version 3.0) and ACE MAESTRO (visible O_3 and NO_2) from the Canadian SCISAT-1 satellite as well as OSIRIS (Limb-Chalmers NO_2 and Sask-MART O_3) from the Swedish Odin satellite. Presenting available data from 2003 to present, the data will be used in combination with three zenith-sky UV-vis spectrometers (UT-GBS, PEARL-GBS, SAOZ), the Bruker 125 HR Fourier Transform Spectrometer (FTS) and three Brewer spectrophotometers (solely for O_3) for our comparisons.

Improved Wintertime Measurements with the CANDAC Rayleigh-Mie-Raman Lidar at Eureka, Nunavut

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The CANDAC Rayleigh-Mie-Raman lidar (CRL), located in Eureka, Nunavut (80N, 86W) is an eight-channel lidar measuring ultraviolet and visible elastic and nitrogen Raman backscatter, water vapour mixing ratio, tropospheric temperature, and depolarization ratio profiles. Measurements of particle extinction and backscatter at two wavelengths means the colour ratio can be calculated, allowing differentiation between fine and coarse mode particles. For the instrument's second intensive measurement campaign, over the 2010/11 winter, significant improvements were made in the data collection and processing, leading to significantly enhanced measurement capability compared with the previous winter. New measurements shall be presented to illustrate these improvements.

Combined analogue and photon-counting elastic backscatter measurements were implemented resulting in an increase in signal dynamic range of 2 orders of magnitude. A corresponding increase in temporal resolution from 10 to 1 minute was seen. Overlap and differential overlap corrections based on a theoretical clear-sky return have been applied, this enables accurate profiles of aerosol extinction to be measured down approximately 200m. A new clear-sky normalisation procedure has also been implemented, reducing clear-sky variance by 2 orders of magnitude in backscatter coefficient profiles.

Aerosol measurements, using the improved analyses, along with depolarisation ratio, water vapour mixing ratio, and temperature from the winter 2010/11 campaign will be shown. Case-study data illustrating mixed-phase clouds, precipitating cirrus clouds, and aerosol–water vapour interactions will be shown along with a season-long time series.

Response of stable water isotopes in Greenland precipitation to varying Eemian ice sheet configurations - a general circulation model study

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I have recently started on my Master thesis, thus the project is only in the starting phase and so far no results have been obtained. This is reflected with the poster being a presentation of the main ideas and thoughts behind the project.

Climate change is a highly political debated subject because of the consequences on the life of humans. One of the direct effects is sea level change, which can be estimated from climate modeling. Information about the extent and volume of the Greenland ice sheet is one of the factors linked to global and local sea level. The previous interglacial period, the Eemian, has been found to have been 3-5°C warmer than present, and is therefore comparable to the expected climate of the following century with estimated global mean temperature changes of 2-4°C. On the basis of climate models and geological sea level traces the Eemian global sea level is known to have been approximately 5 m higher than present. In accordance to this, it is interesting to investigate the extent and height of the Greenland ice sheet during Eemian, since it can be used to estimate the Arctic contribution to sea level changes during the Eemian period. Moreover, it will give an idea of how the Greenland ice sheet may change during the following century.

The isotopic composition of the precipitation on the Greenland Ice Sheet is correlated to the local temperature. This gives the possibility of extracting palaeo-temperatures from isotope profiles of ice cores. However, the atmospheric isotope signal is also affected by the dynamic variations in atmospheric circulation patterns, changes in source areas and the height of the ice sheet. This project will focus on the effect of the ice sheet configuration on the isotopes with the aim of allowing for investigations of the extent of the Greenland Ice Sheet in the Eemian period on the basis of isotopic composition.

With the use of an atmospheric global circulation model the spatial isotopic composition of the precipitation on the Greenland Ice Sheet will be investigated with different Eemian ice sheet configurations. The response of the isotopic composition will be compared to and discussed on the basis of existing isotope measurements from the Eemian period, as well as the present day composition associated with the existing ice sheet and prevailing conditions. It is always complicated when working with the deepest part of an ice core, yet Eemian ice is present in several Greenland Ice Cores including Camp Century, NGRIP, GRIP, GISP-2, Renland, DYE-3 and the new NEEM.

To simulate the Eemian climate the model will be run using sea surface temperatures from a fully coupled global circulation model, and orbital parameters adjusted to palaeo-values. As a first approach the configurations of the Eemian Ice Sheet will be taken from existing resear

A New Radiometer for Continuous Measurements of Chlorine Monoxide in the Canadian Arctic

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Chlorine monoxide is involved in all of the reaction cycles in which chlorine radicals, originally released from chlorofluorocarbons (CFCs), break down ozone in the stratosphere. Accurate long-term measurements of chlorine monoxide (ClO) and ozone (O_3) are needed in order to quantitatively understand the relationship between chlorine containing species and ozone loss rates in the Arctic.

This poster outlines a new radiometer being developed at the University of Toronto which will be capable of making continuous, long-term measurements of ozone and other trace gases involved in Arctic ozone depletion: chlorine monoxide, nitric acid and nitrous oxide.
The instrument will incorporate a state-of-the-art SIS mixer as a detector, balanced calibration with an internal reference load, and enhanced image rejection using a post processing technique. The radiometer will measure radiation in the frequency range of 265 – 280 GHz (~ 1 mm wavelength), originating from rotational transitions of molecules in the atmosphere and will also be designed with the capability to measure lower mesospheric wind speeds.

A smog chamber study of secondary organic aerosol (SOA) formation from the photo-oxidation of β-pinene

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Large quantities of volatile organic compounds (VOCs) are emitted into the atmosphere from vegetation globally. In the troposphere biogenic VOCs, such as β-pinene, undergoes photo-oxidation with hydroxyl radicals and ozone resulting in a diverse range of organic products which based on their volatility can be found in gas and/or particle phase. Aerosol particles influence climate by scattering and absorbing radiation and may influence the formation of cloud droplets, and also they adversely impact human health. However, lack of knowledge on atmospheric particles sources, composition and mechanism of formation lead to the uncertainties in the true impact of them on climate and health.

In the present study, we are using the York University smog chamber ($8m^3$) for investigating the hydroxyl radical initiated oxidation products of β-pinene in gas and particle phase. A number of analytical instruments are sampled from the chamber for quantitative and qualitative analysis. Produced organic particulate mass and particle size distribution are determined by a Differential Mobility Analyzer (DMA) coupled with a Condensation Particle Counter (CPC) and gas phase hydrocarbon concentration is monitored using a gas chromatograph with a flame ionization detector (GC-FID). The main focus which is identification of oxidation products has been accomplished using an atmospheric pressure chemical ionization triple quadrupole mass spectrometer (APCI-MS/MS). Integrating the Counter Flow Membrane Denuder (CFMD) and APCI-MS/MS with the smog chamber has allowed for the online analysis of the particle phase products. The results of this study showed that there are a significant number of products that are formed in gas and particle phase from β-pinene photo-oxidation. Probing the effect of NO_x on products formation by performing β-pinene/HO experiments under varied NO_x condition has been found useful to provide further information regarding products formation pathways. Since NO_x level is variable between rural and urban areas and SOA yields can vary substantially depending on NO_x level, the dependence of SOA yield on the NO_x level has also been investigated.

OSIRIS polar night time nitric oxide densities in the mesosphere – lower thermosphere

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Observations of NO_2 continuum nightglow emissions from OSIRIS, on board the Odin satellite, have been used to derive an eight-year time series of nitric oxide densities, [NO]. OSIRIS is one of the very few current missions deriving ground state NO during the polar winter. The production of NO in this region is strongly dependent on energetic particle precipitation (EPP), and densities are therefore observed to vary with solar activity. Between 2003 and 2009, mean Antarctic winter [NO] in the mesosphere – lower thermosphere decreased by a factor of 3.7, and now, after the prolonged solar minimum that spanned 2008-2009, [NO] in this region is on the rise. As solar activity increases in the next few years, the production of NO is expected to increase. As downward advection readily transports NO_x into the lower mesosphere and stratosphere, such an increase will lead to a greater potential for stratospheric ozone loss. Results are compared with similar SCISAT/ACE-FTS and Odin/SMR data.

Investigation of recent changes in accumulation rates and temperatures observed at the NGRIP using data from multiple shallow ice cores

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Several shallow cores have been drilled at NGRIP (North GReenland Ice core Project). From these cores isotope proles and a density prole has been measured and the cores have been dated. On the basis of these data both annual accumulation and annual average stable isotope values will be calculated for the ice cores. Since the ice core data consist of shallow cores drilled at roughly the same location, it is also possible to conduct a noise level analysis on them. This will also be done.

Instrumental observations of sea level pressure and temperature from 1850 and onwards have been compiled on a global scale, and based on such data sets an atmospheric model based reanalysis, named the 20th Century Reanalysis Project (20CR), have been developed spanning the period from 1871 to present. From the 20CR data set it is possible to obtain pressure, temperature and humidity data from 24 pressure levels at a spatial resolution of 2x2 degrees and a temporal resolution of 6 hours.

As part of the project the accumulation and isotope proles of the NGRIP cores will be compared to large scale atmospheric patterns of pressure and temperature. The goal is to determine which climate signals are present in these ice core data and their associated atmospheric circulation patterns. Condensation temperatures for precipitation events will also be extracted from the 20CR data set and used for comparison with the isotope proles. Furthermore the 20CR accumulation estimates at NGRIP will be compared to the ice core accumulation records to investigate the delity of the 20CR data set at NGRIP.

Initial Sensitivity Study for Investigating the Possible Effect of Black Carbon in Snow and Sea Ice on Climate

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In collaboration with the Danish Climate Centre at the Danish Meteorological Institute, and the Department of Environmental Science at Aarhus University

The long-term aim of this project is to investigate the possible effects of black carbon in snow and ice on the global climate. The presence of dark particles in the bright snow and ice can significantly decrease the albedo and thus cause changes in the local as well as global climate by altering the radiation balance. Earlier studies have shown that a notable part of the observed trend in increasing temperatures and early spring snowmelt since pre-industrial times, could in fact be due to the effect of anthropogenic black carbon in snow and ice.

This work presents 2 initial test cases along with a control run. The first case shows a 20% decrease in the albedo of snow on land and the second case includes an additional 20% decrease in the albedo of sea ice. Both changes are only applied in the Northern Hemisphere. This test is highly unrealistic compared to current estimates of the effect of black carbon. The sole purpose of the cases was to test the changes implemented in the earth system model EC-Earth. Although the results are not realistic they are still worth inspecting as one can observe the spatial distribution of the climate changes compared to the location of snow and sea ice.

Interestingly, the results show that the global mean increase in temperature compared to the control case is the same regardless of whether or not the altered sea ice albedo is included alongside the change in snow albedo. The distributions of the temperature changes in the two cases are, however, different. Snowmelt increases for both cases in coastal regions in the Arctic, but a decrease in snowmelt is seen over some continents (e.g. in Russia and Canada) when the sea ice albedo is decreased together with the snow albedo. Overall, it is seen that even though the albedo decrease is only implemented in the Northern Hemisphere, the effects are also seen in the Southern Hemisphere.

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 initial results of this intercomparison project, including an examination of total column measurements of water vapour retrieved using the PEARL FTIR spectrometer, a microwave radiometer and a sunphotometer. This poster will also discuss future plans to expand the validation datasets to include partial column and profile measurements taken by ground-based radiosonde and lidar instruments at Eureka, as well as satellite measurements made by the Atmospheric Chemistry Experiment (ACE).

Dynamics and historical changes of Petersen Ice Shelf, Nunavut, Canada

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The recent break up of ice shelves along the northern coast of Ellesmere Island has been linked to climate warming and to the loss of multiyear landfast sea ice (MLSI) (Copland et al 2007). The importance of MLSI as a protective barrier for ice shelves was apparent in 2005, when the Petersen Ice Shelf lost 20% of its area within days of a break out of 1020 km² MLSI from Yelverton Bay (Copland et al 2007).Prior to 2005 the MLSI in Yelverton Bay was up to 60 years old and therefore very thick, but since then it has only reformed occasionally as a fringe in front of the Petersen Ice Shelf. These changes are of particular concern for the stability of the remaining Petersen Ice Shelf, yet no prior studies regarding the dynamics, physical characteristics or historical changes of this ice mass exist. This limits the ability to understand how the ice shelf is changing and to predict how it will react to climatic forcing in the future. Therefore the central objective of this thesis is to conduct the first comprehensive survey of the Petersen Ice Shelf by quantifying historical changes in areal extent (from 1950s to 2011), current thickness and mass balance. In addition, the dynamics of the ice shelf and the importance of glacial ice input will be determined using remote sensing techniques such as speckle tracking and interferometry. The presence of the former epishelf lake behind the ice shelf will also be examined from the early 1990s to present using the remote sensing techniques outlined in Veillette et al 2008. This will place recent changes to the freshwater layer into context of ice shelf changes. This research contributes to a broader project, Northern Ellesmere Ice Shelves, Ecosystems and Climate Impacts, that will attempt to improve our understanding of ice shelf dynamics and the conditions leading to ice shelf collapse along the northern coast of Ellesmere Island.

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The Purple Crow LIDAR

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The Purple Crow Lidar (PCL) was recently re-located to a new facility built at the University of Western Ontario's Environmental Research Station (about 10 km north of campus). The PCL has undergone extensive modification and equipment upgrades, and will soon exhibit improved functionality in addition to new operational modes. System upgrades include a 30Hz, 1000 mJ/pulse Litron laser operating at 532 nm, new photo-multipliers and higher vertical-resolution-counting electronics, in addition to the existing 2.44 m liquid mercury telescope. These upgrades will allow high spatial and temporal resolution Rayleigh temperatures to be obtained from the upper troposphere into the lower thermosphere. As well, the addition of new low level channels will allow for the retrieval of higher resolution tropospheric water vapour profiles, as well as tropospheric and stratospheric aerosols backscatter and extinction profiles.

The initiation of modern "soft Snowball" and "hard Snowball" climates in CCSM3

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The problem of the forcing required for the Earth to enter a state of complete glaciation is examined using the Community Climate System Model (CCSM3). All of the simulations performed to address this issue employ the geography and topography of the present-day Earth and are employed to explore the combination of factors, consisting of total solar luminosity, CO_2 concentration, and sea-ice/snow albedo parameterization. Our analyses demonstrate that the critical conditions beyond which runaway ice-albedo feedback will lead to global freezing include (a) a 10-10.5% reduction in solar radiation with pre-industrial greenhouse gas concentrations, (b) a 6% reduction in solar radiation with 17.5 ppmv CO_2, or (c) 6% less solar radiation and 286 ppmv CO_2 if sea-ice albedo is equal to or greater than 0.60 with a snow albedo of 0.78, or if sea-ice albedo is 0.58 with a snow albedo equal to or greater than 0.80. These transition thresholds are very sensitive to the sea-ice and snow albedos. With a 6% reduction in solar radiation, as was approximately the case for the Marinoan glaciation of the Neoproterozoic era, and a CO_2 concentration between one eighth and two times pre-industrial level, when the sea-ice albedo is equal to or less than 0.60, “soft Snowball” solutions are preferred with tropical open-water oceans in the tropics, coexisting with year-round snow-covered continents (implying that tropical continental ice sheets would actually be present). We conclude that a “soft Snowball” is entirely plausible, in which the global sea-ice fraction may reach as high as 76% and sea-ice margins may extend to 10°S and 10°N latitude.