UNIVERSITY OF
TORONTO

2014 Connaught Summer Institute in Arctic Science: Atmosphere, Cryosphere, and Climate

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July 14 - 18, 2014 • Nottasawaga Inn • Alliston, Ontario, Canada

2014 Program

Welcome to the Summer Institute!

The 2014 Connaught Summer Institute in Arctic Science: Atmosphere, Cryosphere, and Climate

The Connaught Summer Institute in Arctic Science: Atmosphere, Cryosphere, and Climate is a new initiative that aims to bring together students and scholars who are engaged in Arctic research, to provide an understanding of the Arctic climate and the processes that control it, and to establish an interdisciplinary forum in which they can discuss current challenges and identify emerging research opportunities in this area. The Summer Institute is supported by the University of Toronto's Connaught Fund and builds on the Summer School program developed by the NSERC CREATE Training Program in Arctic Atmospheric Science (CREATE-AAS).


2011 CREATE-AAS Summer School

The Summer Institute is affiliated with three new networks funded by the Natural Science and Engineering Research Council of Canada (NSERC) Climate Change and Atmospheric Research (CCAR) program: Probing the Atmosphere of the High Arctic (PAHA), the Network on Climate and Aerosols (NETCARE), and the Canadian Sea Ice and Snow Evolution (CanSISE) Network, and with groups at the University of Toronto engaged in laboratory studies of chemistry at the air-ice/snow interface and paleo-reconstructions of Arctic environments. It spans the disciplines of physics, chemistry, earth sciences, geography, environmental science, and related areas, and encompasses the use of experimental, field observation, and modelling methodologies to study the Arctic region.


2012 CREATE-AAS Summer School


2013 CREATE-AAS Summer School

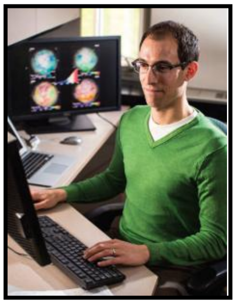
Program Website: http://www.candac.ca/create/ss2014/summerschool2014.html

Summer Institute Speakers and Panelists

Richard Berman
has an undergraduate degree in Engineering Science and a PhD in Atmospheric Physics from the University of Toronto. Richard did field work in atmospheric chemistry and ozone lidar before becoming one of the founders of Spectral Applied Research – a leading supplier of high performance optics for life science imaging systems.

Marianne Douglas
has spent the past 25 years studying environmental change in the polar regions, using paleolimnological techniques to document the effects of accelerated warming in the Arctic. A former Director of the Canadian Circumpolar Institute at the University of Alberta, the focus of her research has been in the Canadian Arctic Islands. She currently lives in Whitehorse, YT and is an Adjunct Professor at Queen's University.

Mark Flanner
is an Assistant Professor in the Department of Atmospheric, Oceanic and Space Sciences at the University of Michigan. His current research ambitions lie in understanding processes that govern cryosphere-climate interaction and feedback.



Chris Fletcher
is an Assistant Professor in the Department of Geography and Environmental Management at the University of Waterloo. His research uses computer models of the global climate system to better understand the processes controlling global climate variability and change, on timescales from seasons to centuries.

Christian Haas
is a Professor and Canada Research Chair in Arctic Sea Ice Geophysics at York University. He has a strong research interest in the role of sea ice in the climate, ecological and human systems both in the Arctic and Antarctic. His research is also aimed at revealing the underlying causes for the recent, strong sea ice retreat in the Arctic.

Jochen Halfar
is an Associate Professor in the Department of Earth Sciences at the University of Toronto at Mississauga. His research is focused on deciphering paleoclimates on different time scales ranging from the past centuries to the Neogene using geochemical, sedimentological, and oceanographic approaches.

Emanuel Istrate

received his PhD in Electrical Engineering from the University of Toronto in 2005. As the Academic Programs Coordinator for the Institute for Optical Sciences he set up a number of courses and training programs for students studying optics. More recently, he has contributed to the IOS and Impact Centre's entrepreneurship and industry collaboration programs, as well as the VicOne program at Victoria College.

Cameron McNaughton

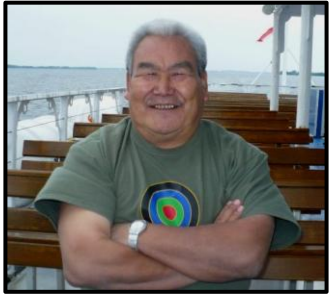
is an Environmental Engineer with Golder Associates Ltd. in Saskatoon, Saskatchewan. He holds a BASc in Environmental Engineering from the University of Waterloo, and an MSc and PhD in Oceanography from the University of Hawai`i. His research focused on airborne measurements of aerosols and trace gases; his work with Golder focuses on air quality, climate and greenhouse gas processes for the mining, oil & gas, and energy industries.

Richard McAloney

is the Director of Technology Management at the Impact Centre at the University of Toronto. He is co-creator of the elite Techno program and has experience with the creation and management of start-ups. He is the co-founder of Axela Inc., a Toronto based molecular diagnostic.

Lisa Miller

is a climate geochemist and the Chair of the Centre for Ocean Climate Chemistry at Fisheries and Oceans Canada. Her fundamental interests lie in the roles the oceans play in planetary evolution and global change. Her research attempts to understand the causes and effects of biogeochemistry and its impact on the global climate.



David Serkoak

was born on the northern part of Nueltin Lake in Nunavut. Education is life-long learning for David and in 1993-1994 he received his Bachelor of Education from McGill-Arctic College. David has worked at many levels in education as a teacher, vice-principal, principal, an instructor at Nunavut Arctic College, and as a curator at the British Museum of Mankind in England. David regularly gives workshops in drum dancing and drum making across Canada and at conferences around the world.

David Tarasick

is a Senior Research Scientist at Environment Canada. He studies tropospheric and stratospheric ozone and is responsible for the Canadian Ozonesonde Network. He conducts atmospheric research using ozonesondes, including field and model process studies of tropospheric ozone and air quality.

Summer Institute Organizing Team

Kimberly Strong
is a Professor in the Department of Physics at the University of Toronto and Director of the University's new School of the Environment. 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 is Deputy PI for PAHA and the CREATE-AAS Training Program Director.

Aubyn O'Grady
is the CREATE-AAS Training Program Coordinator and the Education and Outreach Facilitator for PAHA. Her background is in geography and she spent a number of years living in the Yukon, Canada, where she worked for the Tr'ondëk Hwëch'in First Nations Government and the Dawson City Music Festival.

Zen Mariani
is a PhD student at the University of Toronto, studying radiation and trace gas variability in the high Arctic. He is Chair of the CREATE-AAS Trainees' Advisory Committee. Born and raised in Toronto, Zen has enjoyed visiting the high Arctic several times to perform his research over the past five years.

Connaught Summer Institute Co-Investigators

Jonathan Abbatt
Professor, Department of Chemistry
NETCARE Principal Investigator
www.chem.utoronto.ca/staff/ABBATT/default.htm

Jamie Donaldson
Professor, Department of Chemistry & Dept. of Physical and Environmental Sciences, U of Toronto Scarborough
www.chem.utoronto.ca/staff/DJD/

Sarah Finkelstein
Associate Professor,
Department |of Earth Sciences
soapbox.geology.utoronto.ca/Members/finkelstein

Paul Kushner
Professor, Department of Physics
CanSISE Principal Investigator
pjk.atmosp.physics.utoronto.ca/

Jennifer Murphy
Associate Professor,
Department of Chemistry
www.chem.utoronto.ca/wp/murphygroup/

Kaley Walker
Associate Professor,
Department of Physics
http://www.atmosp.physics.utoronto.ca/~kwalker/

PAHA/PEARL/CANDAC Principal Investigator

James R. Drummond
Professor, Department of Physics and Atmospheric Science,
Dalhousie University
http://fizz.phys.dal.ca/~jrdrummond/

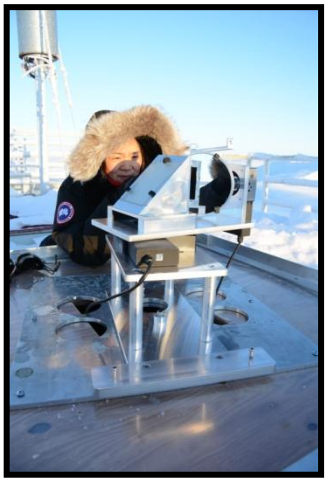
Summer Institute Students

	Name	Institution
1.	C.C. (Chevooruvalappil Chandran) Bajish (PDF)	York University
2.	David Barrett (PhD)	University of Victoria
3.	Jo Browse (PDF)	University of Leeds (England)
4.	Anne Bublitz (PhD)	York University
5.	Matthias Buschmann (PhD)	University of Bremen (Germany)
6.	Stephanie Conway (PDF)	University of Toronto
7.	Laurence Coursol (MSc)	Université du Québec à Montréal
8.	Ghazal Farhani (PhD)	University of Western Ontario
9.	Jonathan Franklin (PhD)	Dalhousie University
10.	Shayamila Gamage (MSc)	University of Western Ontario
11.	Stephanie Hay (PhD)	University of Toronto
12.	Shannon Hicks (MSc)	University of Western Ontario
13.	Gerrit Holl (PDF)	University of Toronto
14.	Ali Jalali (MSc)	University of Western Ontario
15.	Setigui Aboubacar Keita (MSc)	Université du Québec à Montréal
16.	Ja-Ho Koo (PDF)	University of Toronto
17.	Samuel Kristoffersen (PhD)	University of New Brunswick
18.	Zen Mariani (PhD)	University of Toronto
19.	Marzena Marosz-Wantuch (PhD)	York University
20.	Youri Mathieu (MSc)	Université du Québec à Montréal
21.	Emily McCullough (PhD)	University of Western Ontario
22.	Andrew Medeiros (PDF)	Wilfred Laurier University
23.	Joseph Mendonca (PhD)	University of Toronto
24.	Madelyn Mette (PhD)	Iowa State University (United States)
25.	Omid Moeini (PhD)	York University
26.	Eric Mortenson (PhD)	University of Victoria
27.	Brandi Newton (PhD)	University of Victoria
28.	Ashley O'Brien (MSc)	York University
29.	Mikhail Paramonov (PhD)	University of Helsinki (Finland)
30.	Ludovick S. Pelletier (MSc Sept. 2014)	Université du Québec à Montréal
31.	Catherine Phillips-Smith (MSc)	University of Toronto
32.	Sebastien Roche (CREATE intern/MSc)	U Toronto/Lyon 1 University (France)
33.	Meike Rotermund (CREATE intern/MSc Sept. 2014)	Dalhousie / U of Hamburg (Germany)
34.	Reinel Sospedra-Alfonso (PDF)	University of Victoria
35.	Chad Thackery (PhD)	University of Waterloo
36.	Natalie Thompson (PhD)	Iowa State University (United States)
37.	Sophie Tran (PDF)	University of Toronto
38.	Chris Vail (MSc)	University of New Brunswick
39.	Jeff Vankerkhove (MSc)	University of Western Ontario
40.	Zahra Vaziri (PhD)	York University
41.	Dan Weaver (PhD)	University of Toronto
42.	Xiaoyi Zhao (PhD)	University of Toronto

Probing the Atmosphere of the High Arctic (PAHA) is an NSERC CCAR program that is using measurements from the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut and other sites around the Arctic, together with state-of-the-art analysis techniques, to probe the atmosphere of the Canadian High Arctic and analyze the causes of observed changes. The PAHA team is led by **Prof. James R. Drummond (Dalhousie)** and involves researchers at seven universities (Dalhousie, UofT, Western, Saskatchewan, Sherbrooke, York, UNB), and four divisions of Environment Canada, as well as international partners, including the NOAA Earth System Research Laboratory.

The PEARL facility was established in 2005 by the Canadian Network for the Detection of Atmospheric Change (CANDAC). It is located on the northern part of Ellesmere Island, in the vicinity of the Environment Canada Weather Station at Eureka, which is an important link in the support chain for PEARL. PEARL is composed of three interlinked observation sites that are home to about 25 instruments being used to make measurements of the atmosphere from the ground to 100 km. 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 away from all structures, for measurements of the undisturbed terrain about 5 km from the Weather Station.



PAHA is utilizing data from PEARL under three major themes: Composition Measurements (led by Kim Strong), Polar Night (led by Bob Sica), and Satellite Validation (led by Kaley Walker). The first involves studies of the changing composition of the Arctic atmosphere, including greenhouse gases related to the carbon cycle; ozone and related species; biomass burning and continental influence on the Arctic; and clouds, aerosols and precipitation. The Polar Night theme is addressing the immense differences between polar day and polar night; there is a dearth of field measurements during the four months of darkness, which uniquely shapes the atmospheric environment in ways that are still not fully understood. PEARL is a highly desirable site for satellite validation, being in a "sweet-spot" for polar-orbiting satellite overpasses, and so the Satellite Validation theme is making use of PEARL data to establish the accuracy and reliability of Arctic measurements made by instruments on numerous satellite missions. PAHA is also affiliated with international initiatives, including the Network for Detection of Atmospheric Composition Change, the Total Carbon Column Observing Network, the MUSICA water vapour network, and the Aerosol Robotic Network.

All photos by Dan Weaver

NETCARE

Network on Climate and Aerosols

Addressing Key Uncertainties in Remote Canadian Environments

NETCARE (Network on Climate and Aerosols: Addressing Key Uncertainties in Remote Canadian Environments) is an NSERC CCAR program comprised of researchers from ten Canadian universities (Toronto, UBC, UQAM, Waterloo, UQAR, Laval, Dalhousie, Calgary, Sherbrooke, Victoria) and five partner institutions (Environment Canada, Fisheries and Oceans Canada, Alfred Wegener Institute, Max Planck Institute, Johannes Gutenberg University). NETCARE is one of seven networks funded under the NSERC CCAR program and is led by **Prof. Jonathan Abbatt (University of Toronto)**.

NETCARE has been configured around four research activities that address key uncertainties in the field. The first three are focused on specific aerosol-climate connections that remain poorly characterized, and will be addressed through a variety of observational approaches. The fourth activity integrates the results from Activities 1-3, approaching the subject from a comprehensive modeling perspective so as to provide a broad assessment of aerosol climate effects.

Activity 1: Carbonaceous Aerosol
Activity 2: Ice Cloud Formation and Impacts
Activity 3: Ocean-Atmosphere Interactions
Activity 4: Implications of Measurements on Simulations of Atmospheric Processes and Climate

The summer of 2014 is a particularly active field season for NETCARE, with large-scale field work occurring in the Arctic. Ten NETCARE scientists will be on board the Canadian Coast Guard Service Amundsen, a research icebreaker, studying atmospheric and oceanic composition throughout the central Arctic. The cruise will departed from Quebec City on July 8, and will be entering Lancaster Sound on July 17, undergoing a partial exchange of scientists at Resolute Bay, Nunavut on July 24, before heading west through the Northwest Passage.

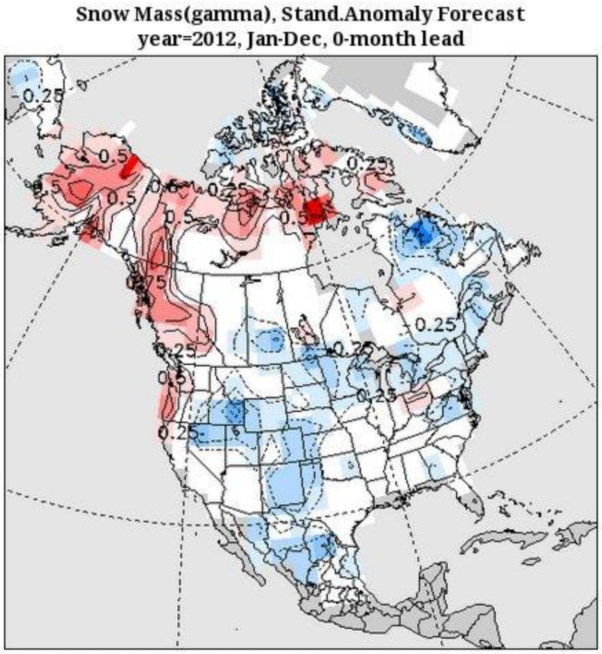
In addition to the Amundsen campaign, an aircraft campaign (on the German POLAR6 aircraft) will be conducted in July 2014 based out of Resolute Bay, Nunavut, aiming to assess the different roles that oceanic input and long range transport play in driving atmospheric composition. For a few days in late July, the aircraft will sample emissions from the Amundsen, as a case study of how ships may lead to atmospheric effects.

CanSISE

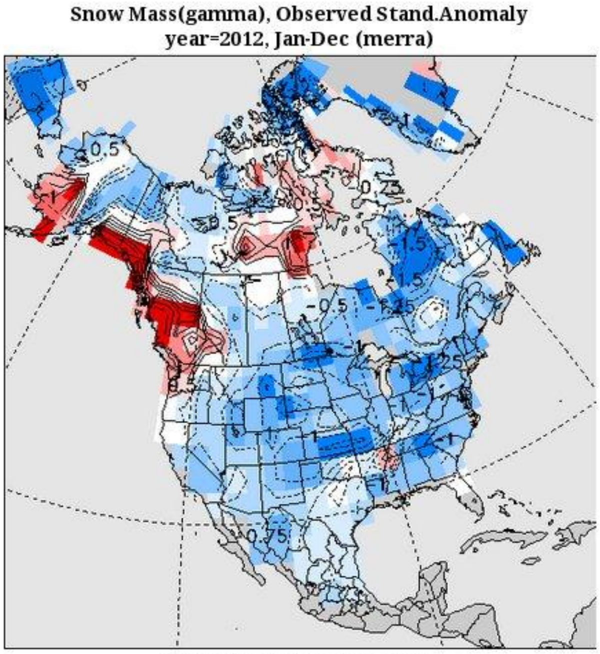
Canadian Sea Ice and Snow Evolution Network

The Canadian Sea Ice and Snow Evolution (CanSISE) Network seeks to advance our ability to predict Arctic sea ice and snow in Canada’s sub-Arctic, alpine, and seasonally snow-covered regions. It aims to exploit advances in climate observations and climate modelling that allow us to forecast these quantities over seasons, years, and even decades. The CanSISE Network is also seeking to understand and exploit the role that Northern Hemisphere snow and sea ice processes play in climate variability and climate change. The CanSISE Network is a collaborative partnership between researchers from eight Canadian universities (UofT, York, McGill, Victoria, Guelph, Waterloo, UBC, UNBC) and three partner organizations (the Climate Research Division of Environment Canada, the Canadian Ice Service, and the Pacific Climate Impacts Consortium). To a unique degree, CanSISE is bringing together university and government researchers with climate modelling and observational expertise. CanSISE is funded under the NSERC CCAR program and is led by **Prof. Paul Kushner (University of Toronto)**.

The CanSISE Network has three Research Areas focussed on (A) prediction, (B) climate change detection and attribution, and (C) process studies related to snow and sea ice and their roles in climate. Each of these research areas has an associated series of collaborative projects whose outcomes are tied to the project's four Deliverables, which represent concrete targets for the Network to complete over its 5 year duration.



12-season calibrated ensemble mean standardized anomaly forecast.



Observed standardized anomaly.

Our thanks to the University of Toronto Connaught Fund for supporting this Summer Institute, and to NSERC for its support through the Climate Change and Atmospheric Research (CCAR) Program and the Collaborative Research and Training Experience (CREATE) Program.

We would also like to acknowledge the following for their additional support of our three networks:

PAHA/CANDAC

Aboriginal Affairs and Northern Development Canada, the Arctic Research Infrastructure Fund, Atlantic Innovation Fund/Nova Scotia Research and Innovation Trust, Canadian Foundation for Climate and Atmospheric Science, Canada Foundation for Innovation, Canadian Space Agency, Dalhousie University, Environment Canada, Government of Canada International Polar Year, NSERC, the Northern Scientific Training Program, Ontario Innovation Trust, Ontario Research Fund, Polar Continental Shelf Program, the US Study of Environmental Arctic Change (SEARCH) and the University of Toronto.

NETCARE

Environment Canada, Fisheries and Oceans Canada, Alfred Wegener Institute, ArcticNet National Centre of Excellence, University of California at San Diego, Arctic Council Arctic Monitoring and Assessment Program (AMAP), World Climate Research Program, Atmospheric Chemistry and Climate initiative of the International Global Atmospheric Chemistry program, and the Surface Ocean-Lower Atmosphere Study (SOLAS) program.

CanSISE

Environment Canada: Atmospheric Science and Technology Division, Canadian Climate Centre for Modelling and Analysis, Canadian Ice Service, and the Pacific Climate Impacts Consortium.

PAHA/CANDAC:	http://www.candac.ca
NETCARE:	http://www.netcare-project.ca
CanSISE:	http://www.cansise.ca/
@CanSISE	https://twitter.com/CanSISE

CREATE-AAS:	http://www.candac.ca/create/
@CREATEArcticSci	https://twitter.com/CREATEArcticSci
/CANDAC	http://www.facebook.com/groups/CANDAC/
CREATE Arctic Science Blog	http://createarcticscience.wordpress.com/

Summer Institute Sponsor

We would also like to thank ABB for its additional sponsorship of the Connaught Summer Institute.

2014 Connaught Summer Institute in Arctic Science: Atmosphere, Cryosphere, and Climate

Nottawasaga Inn, Alliston, Ontario
July 14-18, 2014

Thank-you to ABB for sponsoring the Summer Institute

ABB

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Summer Institute Agenda

Monday July 14, 2014

Lectures will be held in ballroom 16 and posters will be on display in room 19 on the ground floor. Poster boards will be set up on Monday morning and posters can be hung in room 19 any time after arrival. Please refer to page 24 for poster room layout, including individual poster locations.
The Welcoming Icebreaker begins at 8:30 PM at the lower patio, with the Starlight Lounge as alternate location in case of rain (see page 22 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 9:45 AM.		
11:30 – 12:00	Arrival and check-in at Nottawasaga Inn (6015 Ontario 89, Alliston, ON)		
12:00 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 1:45	Welcoming remarks	Kimberly Strong	Introduction
1:45-1:55		Zen Mariani and Network Trainee Committee members	Remarks from representatives of Network Trainee Committees
1:55-2:00		Zen Mariani	Overview of the Career Panel
2:00 – 3:45	Jamboree	All attendees	Speaker and student research jamboree (two minutes and one slide per attendee)
3:45 – 4:15	Coffee break		
4:15 – 5:00	Lecture A	Christian Haas	The sea ice climate system
5:00 – 5:45	Lecture B	Lisa Miller	Arctic oceanography
5:45 – 6:30	Lecture C	David Serkoak	Inuit social history
6:30 – 6:35	Icebreaker introduction	Zen Mariani and the CREATE-AAS TAC	
6:35 – 7:00	Free time (except for poster judges – please meet in ballroom 16)		
7:00	Dinner (Riverview Dining Room)		
8:30	Welcoming Icebreaker	CREATE-AAS Trainees' Advisory Committee (TAC)	

Tuesday July 15, 2014

Lectures will be held in ballroom 16 and posters will be on display in room 19 on the ground floor.
Please stay near your poster for your assigned presentation times during the Poster Session.
Note that awards will be given to the best posters on Thursday evening after the Career Panel. Judges will be evaluating your poster during your assigned presentation times.
Outdoor recreational activities will take place on field 10 (see map on page 21) beginning at 8:30 PM.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Mark Flanner	Cryosphere radiative forcing and climate feedback
9:45 – 10:30	Lecture B	Marianne Douglas	Limnology: what's going on in polar waters
10:30 – 11:00	Coffee break		
11:00 – 12:30	Poster Session	All attendees	Judges for PhD and PDF posters: Mark Flanner, Christian Haas, Jochen Halfar, Lisa Miller Judges for MSc posters: C.C. Bajish, Jo Browse, Gerrit Holl, Reinel Sospedra-Alfonso
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture C	David Tarasick	Polar stratospheric ozone
3:45 – 4:30	Lecture D	Chris Fletcher	Introduction to climate models and modelling
4:30 – 5:00	Coffee break		
5:00 – 5:45	Lecture E	Jochen Halfar	Past Arctic ocean climate evolution
5:45 – 6:30	Lecture F	David Serkoak	Road to Nunavut
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, horseshoes)

Wednesday July 16, 2014

Lectures will be held in ballroom 16 and posters will be on display in room 19 on the ground floor.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Christian Haas	Sea ice change
9:45 – 10:30	Lecture B	Mark Flanner	Monte Carlo modeling of radiative transfer in snow (possible interactive session)
10:30 – 11:00	Coffee break		
11:00 – 11:45	Lecture C	David Tarasick	Tropospheric ozone and transport processes
11:45 – 12:30	Lecture D	Lisa Miller	Carbon cycling in the Arctic Ocean
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 3:00	Free time		
3:00 – 3:45	Lecture E	Marianne Douglas	Paleolimnology and environmental change: truths from the mud, part I
3:45 – 4:30	Lecture F	Cameron McNaughton	Practical applications of soil gas and surface CO_2 flux measurements
4:30 – 5:00	Coffee break		
5:00 – 6:30	Career Panel	Zen Mariani and all attendees	Panelists: Richard Berman, Marianne Douglas, Chris Fletcher, Cameron McNaughton, David Tarasick
6:30 – 7:00	Free time		
7:00	Dinner (Riverview Dining Room)		
8:30 – 9:30	Lecture G	David Serkoak	Inuit traditional music

Thursday July 17, 2014

Lectures will be held in ballroom 16 and posters will be on display in room 19 on the ground floor.
We will take a group photograph today during one of the breaks.
Indoor recreational activities (minigolf) will take place in Sports and Leisure Dome 2 (see map on page 21) beginning at 8:30 PM.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Mark Flanner	Arctic climate sensitivity to black carbon
9:45 – 10:30	Lecture B	Chris Fletcher	Application of models #1: reducing uncertainty in future climate projections through improved understanding of aerosol radiative forcing
10:30 – 11:00	Coffee break		
11:00 – 11:45	Lecture C	Jochen Halfar	High-latitude marine paleoclimatology
11:45 – 12:30	Lecture D	Emanuel Istrate and Richard McAloney	Workshop on writing and reviewing scientific papers
12:30 – 1:30	Lunch (Riverview Dining Room)*		
1:30 – 3:00	Free time (except for poster judges – they will meet in ballroom 16 at 1:30 to decide on poster awards)		
3:00 – 3:45	Lecture E	Marianne Douglas	Paleolimnology and environmental change: truths from the mud, part II
3:45 – 4:30	Lecture F	Lisa Miller	Arctic Ocean and climate change feedbacks
4:30 – 5:00	Coffee break		
5:00 – 6:30	Workshop	Emanuel Istrate and Richard McAloney	Workshop on entrepreneurship
6:30 – 7:00	Poster Awards	Poster judges	The posters awards will be announced
7:00	Dinner (Riverview Dining Room)		
8:30	Free time & optional indoor recreational activity	All attendees	Minigolf

*CREATE-AAS TAC meeting on Thursday at lunch

Friday July 18, 2014

Lectures will be held in ballroom 16. Please remove your poster from room 19 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.
The front desk can store your luggage until departure.

Time		Speaker/Organizer	Topic
7:00 – 9:00	Breakfast (Riverview Dining Room)		
9:00 – 9:45	Lecture A	Chris Fletcher	Application of models #2: understanding the role of snow parameterisations and feedbacks in simulations of climate variability and change
9:45 – 10:30	Lecture B	Christian Haas	Sea ice remote sensing
10:30 – 11:00	Coffee break		
11:00 – 11:45	Lecture C	Jochen Halfar	Crustose coralline algal marine climate reconstructions
11:45 – 12:30	Lecture D	David Tarasick	Tropospheric ozone in the Arctic
12:30 – 1:30	Lunch (Riverview Dining Room)		
1:30 – 2:15	Lecture E	Lisa Miller	Getting it done: time management for scientists within the context of a happy life
2:15 – 3:00	Closing Session	Network Trainee Committees	Closing presentations from network trainee committees, including a short presentation (2:15-2:30) from Dan Weaver on "*Using social media as a science outreach tool*", and the Summer Institute Survey
3:00 – 3:30	Collect your luggage and go to the bus!		
3:30	Depart Nottawasaga Inn for Toronto. Please be ready to leave at 3:30 PM – meet in the front lobby.		
~5:30	Arrive at the Holiday Inn (280 Bloor Street West)		

Jamboree (2:00-3:45, Monday, July 14 in Ballroom 16)

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 keep to time. Please excuse any formatting errors that may have occurred in compiling the slides into one presentation.

Organizers

1. Kimberly Strong
2. Aubyn O'Grady

Speakers and Panelists

1. Marianne Douglas (Queen's University)
2. Mark Flanner (University of Michigan)
3. Chris Fletcher (University of Waterloo)
4. Christian Haas (York University)
5. Jochen Halfar (University of Toronto Mississauga)
6. Lisa Miller (Fisheries and Oceans Canada)
7. David Serkoak
8. David Tarasick (Environment Canada)

Kim Strong will introduce absent speakers:

9. Richard Berman (Spectral Applied Research)
10. Emanuel Istrate and Richard McAloney (Impact Centre)
11. Cameron McNaughton (Golder Associates)

Students

1. C.C. Bajish (PDF) (York University)
2. David Barrett (PhD) (Victoria University)
3. Jo Browse (PDF) (University of Leeds)
4. Anne Bublitz (PhD) (York University)
5. Matthias Buschmann (PhD) (University of Bremen)
6. Stephanie Conway (PDF) (University of Toronto)
7. Laurence Coursol (MSc) (Université du Québec à Montréal)
8. Ghazal Farhani (PhD) (University of Western Ontario)
9. Jonathan Franklin (PhD) (Dalhousie University)
10. Shayamila Gamage (MSc) (University of Western Ontario)

11. Stephanie Hay (PhD) (University of Toronto)
12. Shannon Hicks (MSc) (University of Western Ontario)
13. Gerrit Holl (PDF) (University of Toronto)
14. Ali Jalali (MSc) (University of Western Ontario)
15. Setigui Aboubacar Keita (MSc) (Université du Québec à Montréal)
16. Ja-Ho Koo (PDF) (University of Toronto)
17. Samuel Kristoffersen (PhD) (University of New Brunswick)
18. Zen Mariani (PhD) (University of Toronto)
19. Marzena Marosz-Wantuch (PhD) (York University)
20. Youri Mathieu (MSc) (Université du Québec à Montréal)
21. Emily McCullough (PhD) (University of Western Ontario)
22. Andrew Medeiros (PDF) (Wilfred Laurier University)
23. Joseph Mendonca (PhD) (University of Toronto)
24. Madelyn Mette (PhD) (Iowa State University)
25. Omid Moeini (PhD) (York University)
26. Eric Mortenson (PhD) (Victoria University)
27. Brandi Newton (PhD) (Victoria University)
28. Ashley O'Brien (MSc) (York University)
29. Mikhail Paramonov (PhD) (University of Helsinki)
30. Ludovick S. Pelletier (MSc Sept. 2014) (Université du Québec à Montréal)
31. Catherine Phillips-Smith (MSc) (University of Toronto)
32. Sebastien Roche (CREATE intern/MSc) (University of Toronto/Lyon 1 University)
33. Meike Rotermund (CREATE intern/MSc Sept. 2014) (Dalhousie/University of Hamburg)
34. Reinel Sospedra-Alfonso (PDF) (Victoria University)
35. Chad Thackery (PhD) (University of Waterloo)
36. Natalie Thompson (PhD) (Iowa State University)
37. Sophie Tran (PDF) (University of Toronto)
38. Chris Vail (MSc) (University of New Brunswick)
39. Jeff Vankerkhove (MSc) (University of Western Ontario)
40. Zahra Vaziri (PhD) (York University)
41. Dan Weaver (PhD) (University of Toronto)
42. Xiaoyi Zhao (PhD) (University of Toronto)

Career Panel (5:00-6:30, Weds, July 16 in Ballroom 16)

The Career Panel will take place on Wednesday, July 16 from 5:00 to 6:30 PM and will be moderated by Zen Mariani, Chair of the CREATE-AAS Trainees' Advisory Committee.

This event provides an opportunity for Summer Institute attendees to gain insight into future career paths. This panel of successful science professionals represents a range of job opportunities available to science graduates. The session will begin with a short introduction by each panelist, and proceed into a question and answer session.

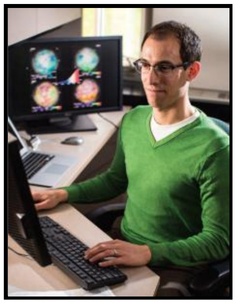
Students are encouraged to think about their professional goals and anticipated career paths, and what questions they might ask during the Career Panel session to help inform or inspire their future job-seeking efforts. A question-submission box will be provided in room 19 during the week to enable students to anonymously submit their questions in writing ahead of time, if they wish to do so. The panel (or specific panelist) will be asked these questions during the session by the moderator. Students may also ask questions directly during the session.

Panelists

Richard Berman
(industry)
CEO at Spectral
Applied Research

Marianne Douglas
(academia)
Adjunct Professor at Queen's
University, Former Director of the
Canadian Circumpolar Institute

Chris Fletcher
(academia)
Assistant Professor at the
University of Waterloo



Cameron McNaughton
(industry)
Environmental Scientist at
Golder Associates

David Tarasik
(government)
Research Scientist at
Environment Canada

Suggested Readings and Websites

Richard Berman: www.spectral.ca
www.andor.com
http://www.osa-opn.org/Content/ViewFile.aspx?id=13288
Suggested reading: Tom Rand, “Waking the Frog” (http://www.tomrand.net/kick-the-fossil-fuel-habit/)
Suggested viewing: https://www.youtube.com/watch?v=wJyUtbn0O5Y (A great link to get a glimpse into what what life science imaging is teaching us about the cellular world)

Marianne Douglas: http://post.queensu.ca/~pearl/adjunct%20profs.htm

Christian Haas: http://lassonde.yorku.ca/users/christianhaas
Suggested readings:
Meier, W., and C. Haas (2011). Changes in the physical state of sea ice. In: AMAP, 2011. Snow, Water, Ice and Permafrost in the Arctic (SWIPA): Climate Change and the Cryosphere. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii + 538 pp., p. 9-4 to 9-18. http://www.amap.no/documents/download/968
Haas, C. (2010), Dynamics versus Thermodynamics: The Sea Ice Thickness Distribution, In: Sea ice / Ed. by David N. Thomas and Gerhard S. Dieckmann Ames, Iowa: Blackwell, ISBN: 978-1-4051-8580-6. http://www.yorku.ca/haasc/Docs/CH004SeaIceBookProof.pdf
Haas, C., Druckenmiller, M. (2009). Ice thickness and roughness measurements, In: Field techniques for sea-ice research / ed. by Hajo Eicken ... Fairbanks: Univ. of Alaska Press, 49-116. http://www.yorku.ca/haasc/Docs/CHAPTER%203.6%20FINAL.pdf

Mark Flanner: http://aoss.engin.umich.edu/people/flanner
Publications: http://aoss-research.engin.umich.edu/faculty/flanner/publications.php
Interactive tool to model snow albedo: http://snow.engin.umich.edu/

Chris Fletcher: http://www.env.uwaterloo.ca/u/c5fletch
Suggested viewing: http://www.easterbrook.ca/steve/2014/05/tedx-talk-should-we-trust-climate-models/

Jochen Halfar: http://www.utm.utoronto.ca/~w3halfar/index.html

Emanuel Istrate and Richard McAloney (Impact Centre): http://www.impactcentre.utoronto.ca/

Cameron McNaughton: http://www.linkedin.com/pub/cameron-s-mcnaughton/1/558/a80
http://www.researchgate.net/profile/Cameron_Mcnaughton/info
http://www.golder.ca/en/modules.php?name=Pages&sp_id=331

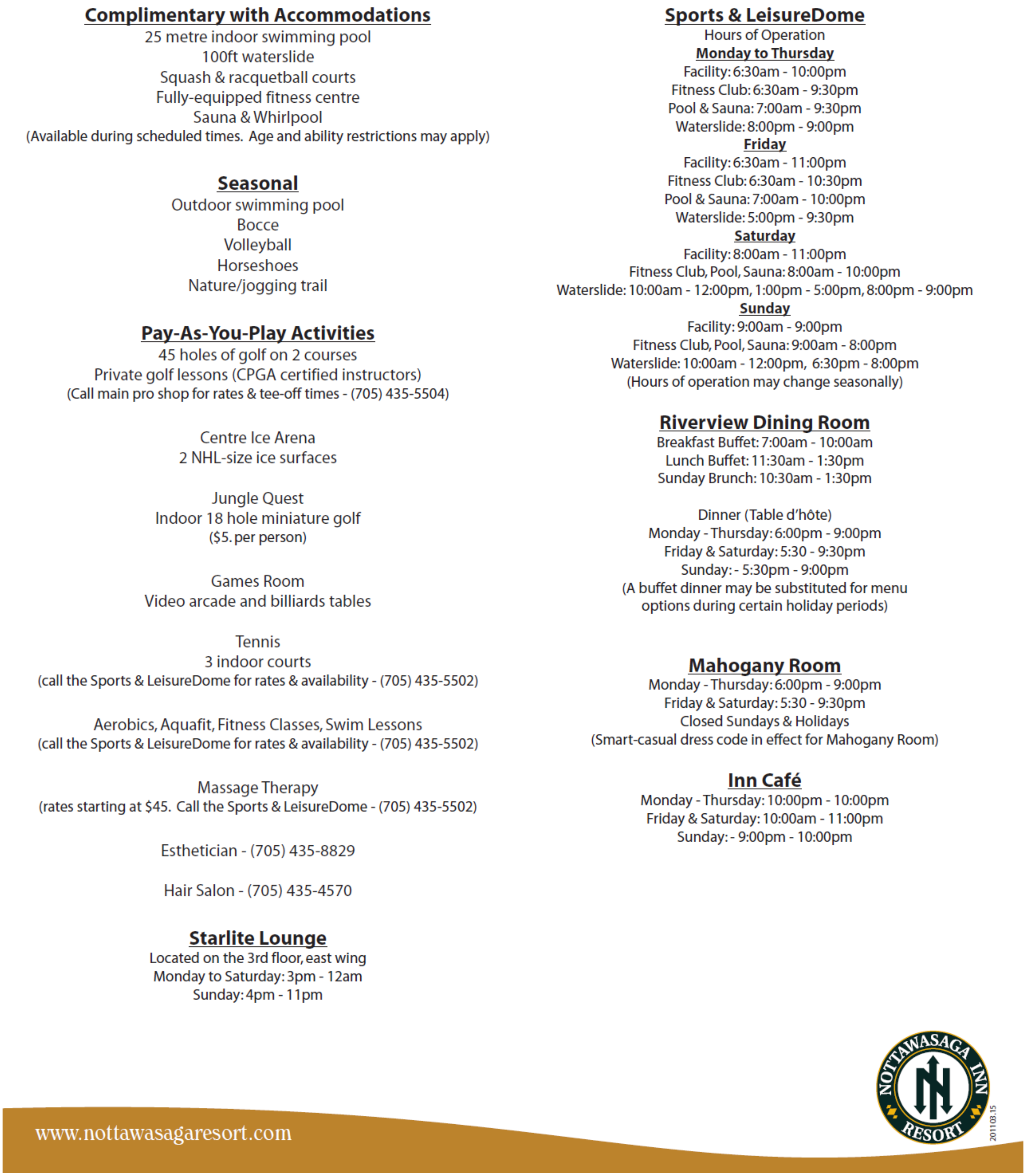
Lisa Miller: http://members.shaw.ca/ttmc/index.html

David Serkoak: https://margopfeiff.wordpress.com/tag/david-serkoak/
http://www.firstencounters.ca/en/gallery/videodetails?videoid=71

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

David Tarasick: http://www.ec.gc.ca/scitech/default.asp?lang=En&n=F97AE834-1&xsl=scitechprofile&formid=6C6D07FB-88C9-4227-AABE-462D19B78011

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)

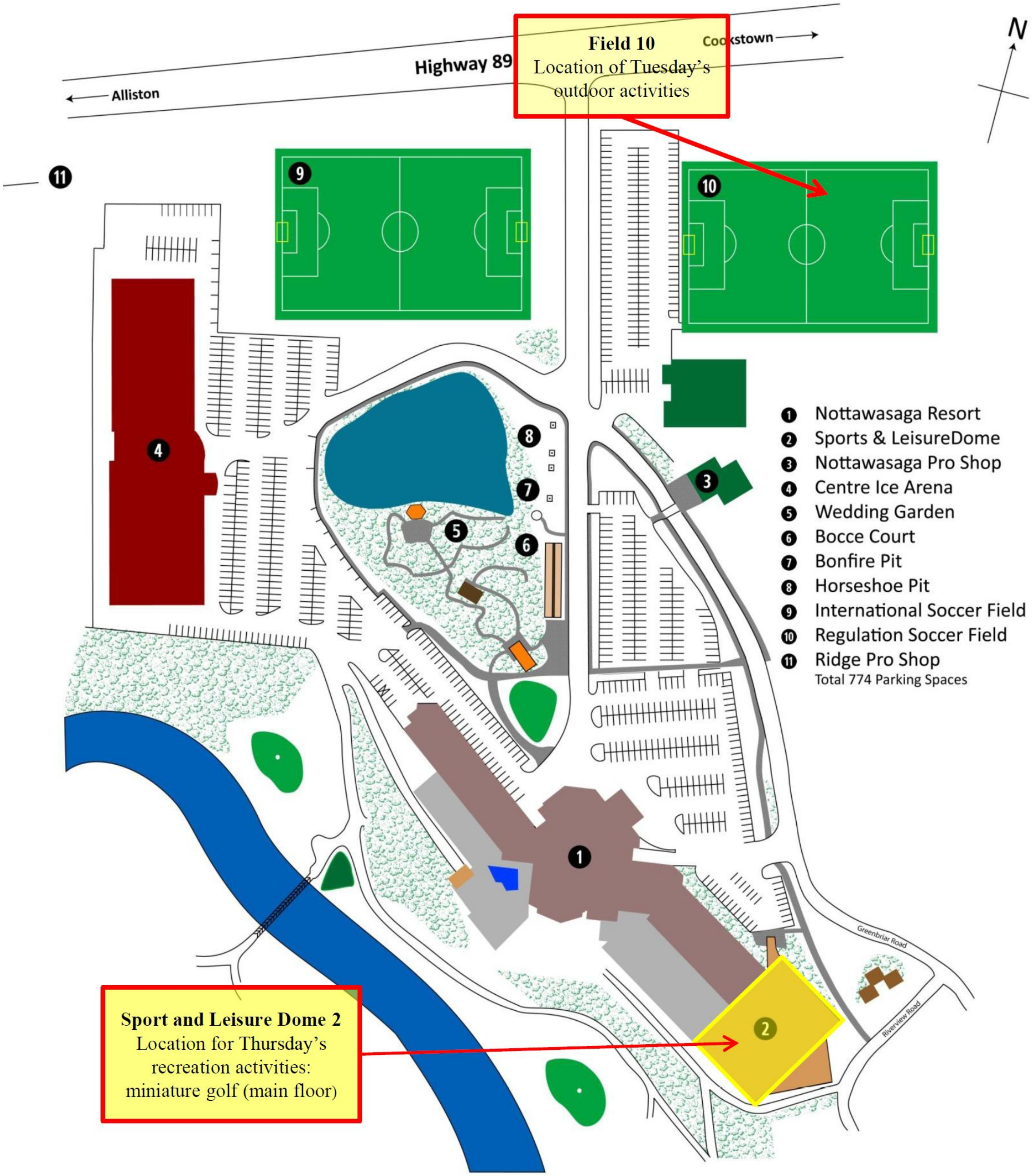
Inn Café

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

www.nottawasagaresort.com

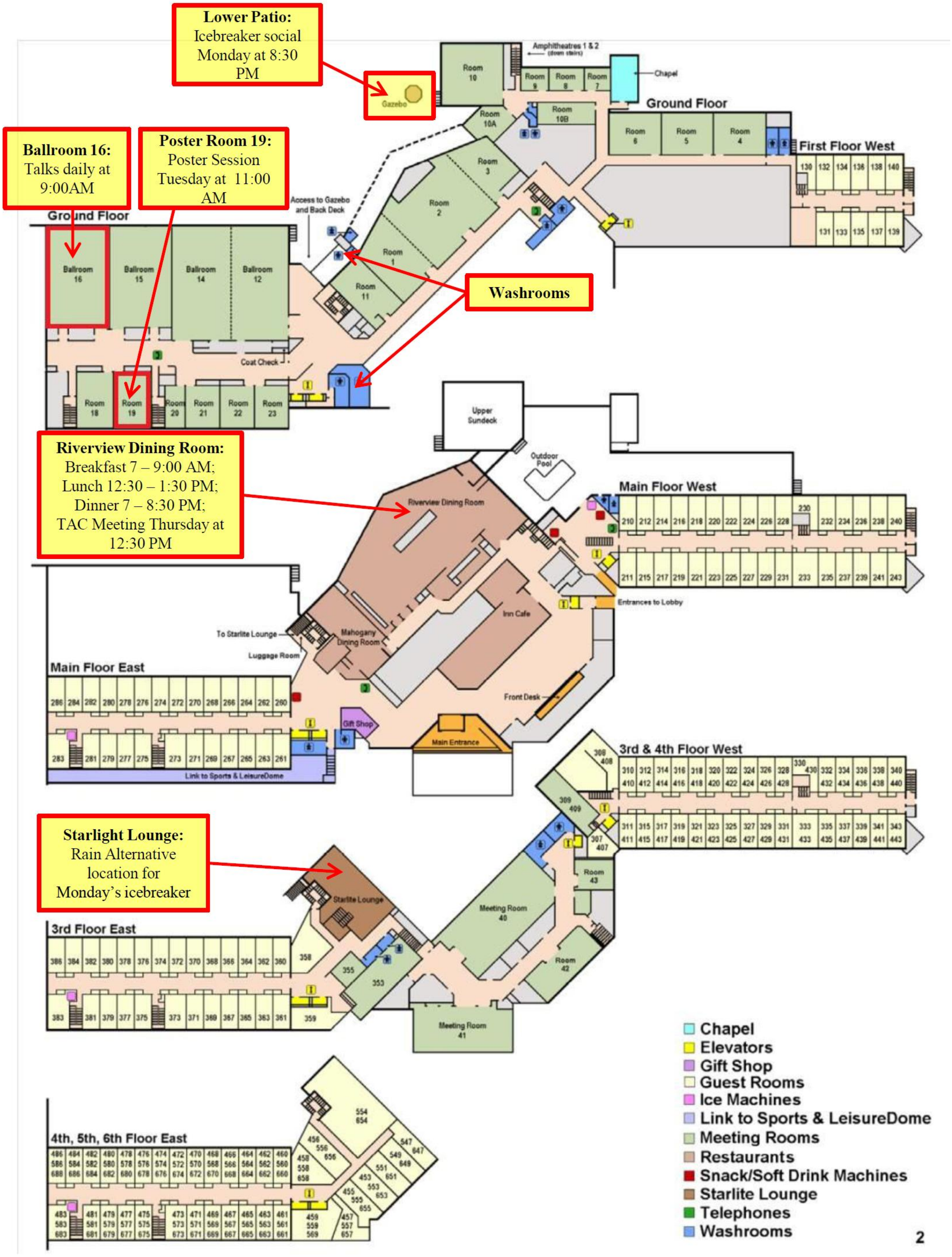
2011.03.15

Nottawasaga Inn Maps



Field 10
Location of Tuesday's outdoor activities

Sport and Leisure Dome 2
Location for Thursday's recreation activities: miniature golf (main floor)



Lower Patio: Icebreaker social Monday at 8:30 PM

Ballroom 16: Talks daily at 9:00AM

Poster Room 19: 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

Starlight Lounge: Rain Alternative location for Monday's icebreaker

Poster Session (11:00-12:30, Tuesday, July 15, room 19)

Posters will be displayed in room 19 from Monday through Friday morning. Poster boards will be set up on Monday morning. Please mount your posters in the locations indicated on the next page sometime on Monday. Please stay near your poster for your assigned session on Tuesday, as judges will be visiting during that time. Note that awards will be given to the best posters during the awards ceremony before dinner on Thursday. Please take down your poster before lunch on Friday.

Judges for PhD and PDF posters:

Mark Flanner
Christian Haas
Jochen Halfar
Lisa Miller

Judges for MSc posters:

Session A: Jo Browse & Reinel Sospedra-Alfonso
Session B: C.C. Bajish & Gerrit Holl

Session A (11:00 – 11:45 AM):

PhD/PDF

C.C Bajish (PDF)
Matthias Buschmann (PhD)
Jonathan Franklin (PhD)
Gerrit Holl (PDF)
Samuel Kristoffersen (PhD)
Marzena Marosz-Wantuch (PhD)
Andrew Medeiros (PDF)
Joseph Mendonca (PhD)
Madelyn Mette (PhD)
Mikhail Paramonov (PhD)
Chad Thackery (PhD)
Sophie Tran (PDF)
Zahra Vaziri (PhD)

MSc

Laurence Coulson (MSc)
Shayamila Gamage (MSc)
Shannon Hicks (MSc)
Ashley O'Brien (MSc)
Catherine Phillips-Smith (MSc)
Meike Rotermund (MSc)
Chris Vail (MSc)

Session B (11:45 – 12:30 PM):

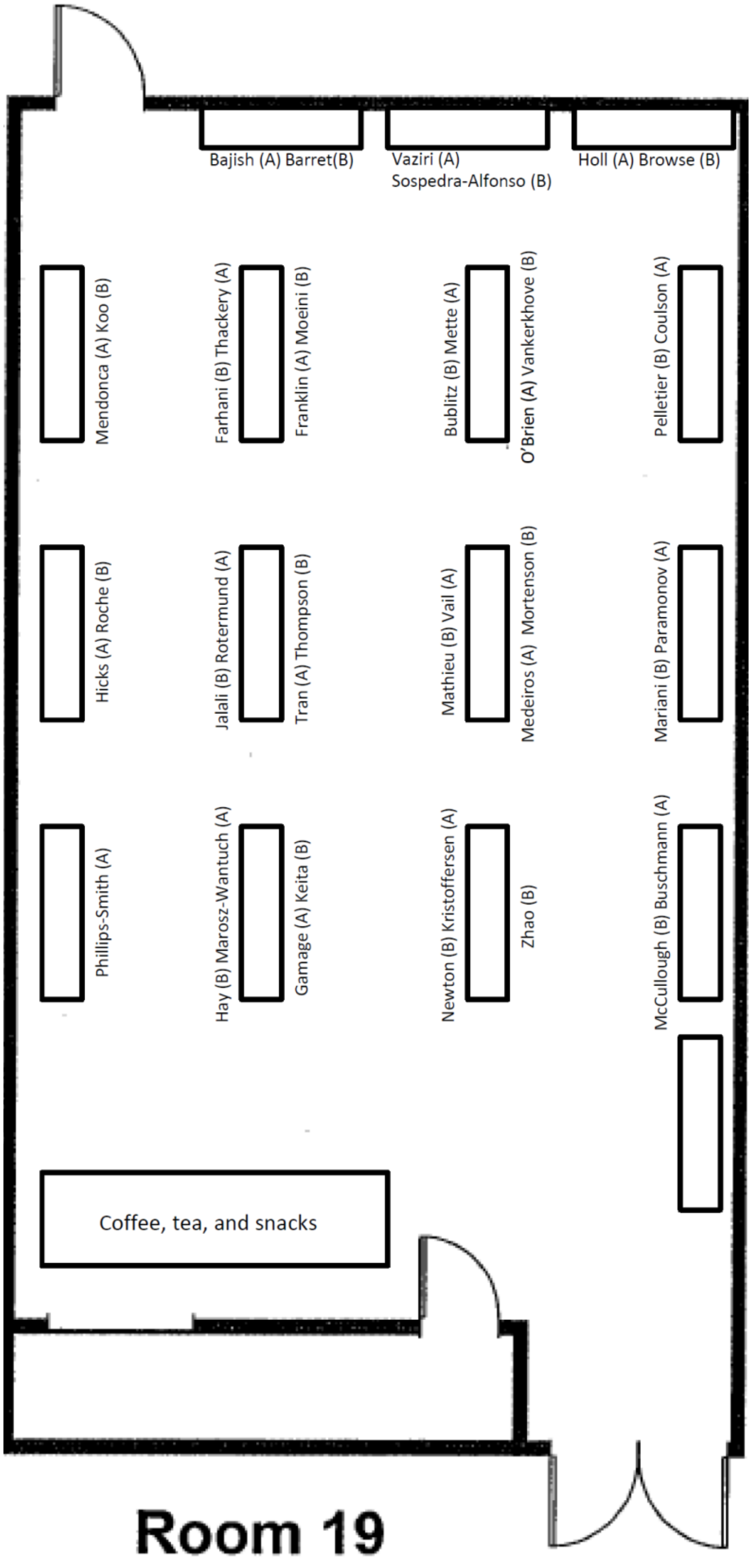
PhD/PDF

David Barrett (PhD)
Jo Browse (PDF)
Anne Bublitz (PhD)
Ghazal Farhani (PhD)
Stephanie Hay (PhD)
Ja-Ho Koo (PDF)
Zen Mariani (PhD)
Emily McCullough (PhD)
Omid Moeini (PhD)
Eric Mortenson (PhD)
Brandi Newton (PhD)
Reinel Sospedra-Alfonso (PDF)
Natalie Thompson (PhD)
Xiaoyi Zhao (PhD)

MSc

Ali Jalali (MSc)
Setigui Aboubacar Keita (MSc)
Youri Mathieu (MSc)
Ludovick S. Pelletier (MSc)
Sebastien Roche (MSc)
Jeff Vankerkhove (MSc)

Poster Room Layout



Poster Abstracts

Decadal circumpolar variability of Antarctic sea ice revealed by satellite observation and coupled general circulation model output

Chevooruvalappil Chandran Bajish[1], S. Aoki[2], B. Taguchi[3] and N. Komori[3]

[1]Department of Earth and Space Science, York University, Toronto, Canada
[2]Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan
[3]Earth Simulator Center, JAMSTEC, Yokohama, Japan

In the last 30 years, contrary to the Arctic sea ice rapid decrease, the Antarctic sea ice extent has been showing an increasing trend, with significant regional scale increase at the Ross Sea sector and decrease at Bellingshausen Sea. This long-term Antarctic sea ice variability (~10-30 years) is difficult to examine due to the limitation in the satellite observation record and its mechanism has not been sufficiently addressed yet. In order to study the decadal variability in the Antarctic sea ice and the processes driving it, this study examined the relationship between ice, ocean and atmosphere using a high resolution coupled ocean-atmosphere-ice model (CFES) along with observational data derived from satellite.

The observational records of sea ice have revealed a circumpolar variability of sea ice edge (SIE) on decadal time scale (11-16 years). Sea surface temperature (SST) observations and southern annular mode (SAM) record also showed variation on similar timescales with warm (cool) anomaly corresponding to retreat (extension) of SIE at negative (positive) SAM. These coupled relationships are also confirmed from our model study where the leading modes of sea iceconcentration (SIC) is circumpolar pattern with a dominant time scale of 12-17 years and the leading mode of SST also has similar pattern with SIC showing a high degree of inverse correlation. The modeled SAM significantly correlates with the leading modes of both SIC and SST, representing the same structure with the observations.

The oceanic variability especially in the SST sets the decadal variability in the Antarctic sea ice. The atmosphere, especially SAM, initiates the decadal sea ice variability with related wind anomalies induce Ekman currents in the mixed layer which produce SST anomalies with the upwelling of the warmer subsurface water at a decadal time scale (14-18 years). The decadal SAM and oceanic variability are coupled through dynamic and thermodynamic feedback. Therefore, the natural oceanic decadal variability its impact to the atmosphere is the key in the coupled ice-ocean-atmosphere system.

Author contact: ccbajish@yorku.ca

Measuring and modelling changes in under-ice dissolved oxygen content of Canadian Arctic lakes with changing climate conditions

David Barrett[1], T. Prowse[1,2], and F. Wrona[1,2]

[1]Water and Climate Impacts Research Centre, Department of Geography, University of Victoria, Victoria, Canada
[2]Water and Climate Impacts Research Centre, Environment Canada, Victoria, Canada

It is widely accepted that the Arctic will experience an accelerated rate of climate change when compared to the rest of the world. The impacts of this change on Arctic lakes are of great importance, as many aspects of tundra freshwater ecosystems will be greatly impacted. Understanding and modelling the effect of warming temperatures on lake ice quality/quantity and resulting changes to dissolved oxygen (DO) levels will help to illuminate how these ecosystems will be impacted.

By using the Arctic Lake Monitoring System (ALMS), a combination of water quality sondes, acoustic ice profilers and weather stations, a high-resolution dataset of under-ice DO levels will be collected. The collection of other water quality parameters will aid in explaining observed under-ice trends of DO. The collection of data from the ALMS monitoring buoys, potentially deployed at two field sites in the high Arctic, will be supplemented by spot sampling of other similar lakes in the area to measure spatial variation. Data from previous deployments of the ALMS system in Noell Lake, Northwest Territories, will be used in conjunction with future deployments at other locations in the Arctic to create a longer dataset.

After the data has been collected, an attempt will be made to calibrate and then predict future changes to DO levels under different climate scenarios. This will be done using the MyLake model, a daily, process-based, model of water quality parameters. Furthermore, it is hoped that spot sampling will further enhance the validation of the model for the region, increasing its predictive potential. Further experiment parameters are likely to emerge as the project develops. It is hoped that this research will aid in understanding the wide-reaching effects of a changing climate on freshwater lakes in the Canadian Arctic.

Author contact: dcbarrett@gmail.com

The complex response of Arctic cloud condensation nuclei to sea-ice retreat

Jo Browse[1], K.S. Carslaw[1], G. W. Mann[1], C. E. Birch[1], S.R. Arnold[1], and C. Leck[2]

[1]School of Earth and Environment, University of Leeds, Leeds, UK
[2]Department of Meteorology, Stockholm University, 10691, Stockholm, Sweden

Loss of summertime Arctic sea ice will lead to a large increase in the emission of aerosols and precursor gases from the ocean surface. It has been suggested that these enhanced emissions will exert substantial aerosol radiative forcings, dominated by the indirect effect of aerosol on clouds. Here, we investigate the potential for these indirect forcings using a global aerosol microphysics model evaluated against aerosol observations from the ASCOS campaign to examine the response of Arctic cloud condensation nuclei (CCN) to sea-ice retreat. In response to a complete loss of summer ice, we find that north of 70°N emission fluxes of sea-salt, marine primary organic aerosol (OA) and dimethyl sulphide increase by a factor of ~10, ~4 and ~15 respectively. However, the CCN response is weak, with negative changes over the central Arctic Ocean. The weak response is due to the efficient scavenging of aerosol by extensive drizzling stratocumulus clouds. In the scavenging dominated Arctic environment, the production of condensable vapour from oxidation of dimethyl sulphide grows particles to sizes where they can be scavenged. This loss is not sufficiently compensated by new particle formation, due to the suppression of nucleation by the large condensation sink resulting from sea-salt and primary OA emissions. Thus, our results suggest that increased aerosol emissions will not cause a climate feedback through changes in cloud microphysical and radiative properties.

Changes in Sea Ice Thickness and Extreme Ice Features in the Beaufort Sea using AEM data

Anne Bublitz[1] and C. Haas[1]

[1]Department of Earth & Space Science and Engineering, York University, Toronto, Canada

Airborne electromagnetic measurement systems (AEM) measure sea ice thickness by inducing electromagnetic fields into the sea water under the ice. The inter annual variability of multi-year ice thickness and extreme ice features in the Beaufort Sea has been analysed using the data of 4 airborne EM campaigns in the spring of the years 2009, 2011, 2012 and 2013 in the Beaufort Sea. The measurements were made in April which being at the end of winter is the time when ice thickness is close to its maximum, and therefore representing the most extreme conditions. The observations made in this study are important to assess the state of sea ice and extreme ice features in the Beaufort Sea can be used to evaluate the hazard potential of sea ice for offshore operations.

Within this analysis extreme ice features are defined sea ice structures thicker than 6 m and wider than 100 m. These features can have very different characters, ranging from big individual pressure ridges to very broad hummock fields that are continuously thick. Extreme ice features often occur in clusters that will be in a distance from the next cluster. They occur in multi-year ice as well as first-year ice and these features found in the first-year ice region form in prominent shear zones and near the coastal fast ice edge. Results] show that the extreme ice features had mean thicknesses between 7 and 9 m and were up to 300 m wide. The data has been separated into multi-year ice and first-year ice areas using SAR images to define the boundaries of the different areas. The thickest multi-year ice throughout the years has been found along the edge of the multi-year ice zone.

Looking at first-year ice and multi-year ice regimes separately shows that the first-year ice thickness distributions has strong characteristic modes between 1.80 m and 2.10 m, representing the vast majority of the first year ice. Since the survey flights 2011, 2012 and 201 covered the same region these results also indicate, that the young ice in 2013 was on average about 20 cm thinner than in 2011 and 2012.

The multi-year ice regimes of 2009 and 2011 are characterized by very thick ice with modal thicknesses of 3 m and higher. Thick multi-year ice does not appear in 2013. The only significant mode is less than 2 m thick, which is nearly as thin as the first-year ice observed in the same year. The similarity in modal thicknesses in 2013 indicates that the majority of the multi-year ice regime in the Beaufort Sea is not thicker than firs-year ice anymore and thus presents less of a hazard than in earlier years. The thin multi-year ice cover 2013 could be explained by a very thin multi-year ice cover at the end of the summer 2012, which may have been covered by snow early in fall 2012. Snow covered ice has a growth disadvantage compared to the newly forming and snow free first-year ice, so that similar thicknesses in April would be plausible.

Towards a full seasonal cycle of total column CO_2 and CH_4 in the high Arctic

Matthias Buschmann[1], N. M. Deutscher[1], M. Palm[1], T. Warneke[1], C. Weinzierl[1], and J. Notholt[1]

[1]Institute of Environmental Physics, University of Bremen, Bremen, Germany

We employ Fourier Transform InfraRed (FTIR) Spectrometry to measure the total column amount of atmospheric trace gases via solar absorption spectroscopy, e.g. within the Total Carbon Column Observing Network (TCCON).

During winter in the high Arctic, there is no sunlight available because the sun is permanently below the horizon. We deployed a new near-infrared detector in our instrument in Ny Ålesund (79° N) to increase sensitivity in low light conditions and use the sunlight reflected by the moon as an infrared light source above the atmosphere to perform absorption spectroscopy. At autumn equinox we are able to take both, sunlight and moonlight spectra, thus validating the new approach. Here we present the successful retrieval of total column dry air mole fractions of CO_2 and CH_4 in the 2012/2013 and 2013/2014 winter and it's validation with TCCON.

An Investigation of Atmospheric Model Biases Due to Thin Ice Clouds during Polar Night

Laurence Coursol[1], J.-P. Blanchet[1], and P. Gauthier[1]

[1]Département des sciences de la Terre et de l'atmosphère, ESCER, UQÀM, Montréal, Canada

The formation and the evolution of cold temperature anomalies in the polar atmosphere is a challenging process hard to predict well enough to insure reliability of medium range forecast in the high and mid latitudes during winter. Atmospheric models are notoriously deficient in simulating the role of clouds in forcing the large scale circulation. One of the central processes is the treatment of radiation and microphysics in ubiquitous thin ice cloud forming during the Arctic night. Using observation data from ground site at PEARL and concurring satellite data from the A-Train, we are planning to investigate the biases found in GEM through the data assimilation scheme. A particular emphasis is put on the correlation with thin ice cloud types, microphysics, precipitation and radiation.

Determination of the systematic uncertainties associated with the merging of analog and digital photon count profiles for LIDAR temperature retrievals

Ghazal Farhani[1], R. J. Sica[1], and P. S. Argall[2]

[1]Dept. of Physics and Astronomy, The University of Western Ontario, London, Canada
[2]School of Applied Science and Technology, Faculty of Technology, Fanshawe College, London, Canada

The large dynamic range of returns from lidar sounding of the atmosphere requires the use of more than one mode of detection (that is photon counting mode and analog mode) or multiple detectors, for the backscattered signal. Western's Purple Crow Lidar (PCL), uses Licel counters and phototubes, which can simultaneously acquire measurements in both photon counting and analog modes, extending the dynamic range of the system to 5 orders of magnitude. For the retrieval of Rayleigh scatter temperatures, these two photocount profiles are merged together into a single profile, the process called merging or gluing.

Merging has been described in several studies, however, the systematic uncertainties created by the merging process in the retrieved temperature have not been studied quantitatively. In this study, we quantify these uncertainties by using a computer model which simulates both digital and analog counts and their individual uncertainties. Then, we merge these synthetic count profiles. The advantage of this method is that we can control and change the input uncertainty values, and investigate their effect on the final temperature profile (for example we can investigate the effect of deadtime correction uncertainty).

The simulation also allows us to separate the effects of uncertainty due to the deadtime correction from the effects of uncertainty introduced by the the merging procedure itself. We find that the effect of the merging process uncertainty on the temperature profile is negligible when the deadtime correction has uncertainty less than 15%. However, at larger uncertainties, the merging uncertainty becomes important, as the temperature difference becoming greater than 1.0 K (which is much larger than the statistical uncertainty of the retrieval).

Fourier Transform Spectroscopy at the Dalhousie Atmospheric Observatory

Jonathan E. Franklin[1], J. R. Drummond[1], and A. Tikhomirov[1]

[1]Dalhousie University, Halifax, Nova Scotia, Canada

Remote sensing of atmospheric trace gases using Fourier transform spectrometers is a proven technique whereby the atmosphere is probed via its effects on the solar spectrum. Higher-resolution instruments are capable of providing some information on the vertical distribution of trace gases; however, the quality of this information is very sensitive to the mathematical details of the signal processing.

This work focuses on the commissioning of a refurbished ABB Bomem DA8 spectrometer at the Dalhousie Atmospheric Observatory (DAO) located in Halifax, Nova Scotia (44.6°N, 63.6°W). Halifax is ideally situated to monitor the pollution outflow from northeast North America. We have detected events associated with biomass burning in the Canadian boreal forest, as well as events associated with anthropogenic pollution from the industrial regions surrounding the Great Lakes.

We present a selection of trace gas column results from the first three years of DAO measurements that exhibit a variety of acute pollution events overlaid on the expected seasonal cycles. We also present a description of our data analysis algorithms with a focus on the computation of the solar spectrum.

Water Vapour Retrieval Using CRL (CANDAC Raman Lidar), Eureka

S. Mahagammulla Gamage[1], E.M. McCullough[1], C.Perro[2], J.Hopper[2], T.J. Duck[2] and R.J. Sica[1]

[1]Department of Physics and Astronomy, The University of Western Ontario, London, ON, Canada
[2]Department of Physics and Atmospheric Science, Dalhousie University, Halifax, NS, Canada

The Canadian Network for the Detection of Atmospheric Change has installed a Rayleigh -Mie-Raman (RMR) lidar in Eureka, Nunavut (79°59'N, 85°56'W) to study the thermodynamic and radiative environments of the lower atmosphere in the High Arctic. The RMR lidar is designed to create profiles of tropospheric water vapour as well as aerosols, clouds and temperature from near the surface to the lower-stratosphere. Measurements taken using the UV laser during the Canadian Arctic ACE validation campaign 2014 are currently being analyzed to retrieve water vapour mixing ratios. The raw measurements will be corrected for the background noise and calibrated using coincident radiosonde flights. Finally, the water vapour mixing ratios for specific days will be analyzed to study changes in the amount of water vapour due to dynamics.

Author contact: smahagam@uwo.ca, shamgamage@purplecrowlidar.ca

The Atmospheric Available Energy and its Trends

Stephanie E. Hay[1], P. R. Bannon[2], and S. Lee[2]

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The available energy of the atmosphere is the theoretical maximum amount of the total potential energy (i.e., the sum of the internal and gravitational energies) that can be converted into kinetic energy. It includes contributions from baroclinic available potential energy as well as convective available potential energy. We define a reference atmosphere which is isothermal and hydrostatic. The minimization of an energy availability function between this reference and the actual atmosphere determines the equilibrium temperature of the reference atmosphere and the available energy. This approach is general and includes the effects due to water vapor, hydrometeors, and terrain. Using reanalysis data, we calculate the available energy due to each component (i.e., dry air, water vapor, hydrometeors) of the atmosphere at every grid point. Thus, we are able to calculate a value of the available energy both locally and globally. ECMWF reanalysis data suggests that the equilibrium temperature of the atmosphere and its available energy have been increasing from 1979-2012. Regionally we detect an increase in available energy over the western tropical Pacific Ocean and a decrease over the central/eastern Pacific. This structure suggests a strengthening of the Walker circulation.

Automating the Purple Crow Lidar

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The Purple Crow LiDAR (PCL) was built to measure short and long term coupling between the lower, middle, and upper atmosphere. The PCL uses a Neodymium: Yttrium-Aluminium-Garnet (Nd:YAG) solid state laser to produce a green beam at 532 nm with an average power of 950 mJ. The laser beam is directed skyward and photons backscattered from the atmosphere are collected and focused by the liquid mercury telescope onto 4 photomultipliers (PMTs). Two of the channels have the capability to simultaneously measure analog and digital photocounts. These are used for the Rayleigh-scatter and vibrational nitrogen channels, as well as aligning the laser. The other channels are digital; one channel is used with an attenuator for the elastic return, the other for water vapour. With these channels, the PCL is capable of measuring temperature, density, pressure, and water vapour mixing ratio profiles. In time, we may increase the altitude range of the lidar as well as expand our detection capabilities to include particulates. Our current priority is to automate our instrument control system. Automation will enable us to work remotely, thereby removing the need to be on site during operations. We are losing measurements by being reliant on a full night of clear weather and the inability to obtain observers on short notice throughout the night. If we can work remotely, the PCL may be turned on and run at any time of night, so long as it is clear, and observers will not have to be present.

The initial part of my M.Sc. thesis is to automate two key components of the PCL - the alignment mirror and a cloud/precipitation detection system. The first task will be to write code for the alignment mirror. The main challenge is that stray clouds will introduce a bias in the alignment data. This poster describes our method to limit this interference and keep the lidar aligned throughout the night. We are also looking into options for weather monitoring and controlling our hatch. Our top two choices are the Boltwood Cloud Sensor II and the Aurora Cloud Sensor. These sensors will be able to monitor wind, precipitation, and cloud cover as well as turn off the laser and close the hatch once observing conditions deteriorate. The device we choose will then be integrated into our lidar control system.

Comparisons of CH_4 from ACE, GOSAT, and PEARL

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Methane (CH_4) is the third most important greenhouse gas on Earth, and second only to carbon dioxide in its contribution to anthropogenic global warming. Accurate and precise observations of methane are essential to quantitatively understand sources and sinks. Global observations can only be achieved using spaceborne observations. Satellite-based remote sensing of methane (or, indeed, any gas) is an ill-defined problem, and measurements need to be validated before they can be used for scientific or other purposes. In this poster, we introduce the relevance of methane and the need to validate spaceborne measurements. Two satellite instruments are introduced: the Canadian Scisat-1 ACE-FTS, a solar occultation spectrometer operating since 2003, and the Japanese GOSAT TANSO-FTS, a down-looking Fourier Transform Spectrometer operating at solar and terrestrial infrared wavelengths, since 2009. Measurements are validated against the ground-based Bruker Fourier transform Infrared (FTIR) spectrometer, measuring solar absorption at the Polar Environmental and Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut (80°N, 86°W) since 2006. This validation is performed by comparing pairs of measurements that are sufficiently closely collocated in time and space, and that are either both inside, or both outside, the polar vortex. Next, measurements need to be interpolated on a common vertical grid. To account for different vertical resolutions and sensitivities, the high-resolution measurement is smoothed using the averaging kernel from the low-resolution one. Comparisons are either performed for different vertical levels, or for integrated partial columns for the height range where both instruments share sensitivity. Finally, these results will serve as a guideline on how to use the methane products from ACE and GOSAT within the Arctic region. Note that results presented on the poster are preliminary and still subject to change.

Comparison of retrieval methods of atmospheric temperature using the Purple Crow Lidar Rayleigh temperature climatology

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Temperatures retrievals from Rayleigh-scattering lidar measurements have been performed using the algorithm given by Chanin and Hauchecorne (1980; henceforth CH) for the last 3 decades. Recently Khanna et al. have presented an inversion approach to retrieval atmospheric temperature profiles. This method uses a nonlinear inversion method with a Monte Carlo technique to determine the statistical uncertainties for the retrieved nightly average temperature profiles.

Argall and Sica (2007) used the CH method to produce a climatology, which was compared with the CIRA-86 model. The CH method requires the assumption of a pressure at the highest from a model. The uncertainty due to this assumption causes the top two scale heights of temperatures from profile to be discarded until the retrieval is no longer sensitive to the seed (assumed) pressure. An inversion approach allows the corrected lidar photocount profile to be integrated upward as opposed to downward as required by the CH method. Seeding the retrieval at the lowest instead of top height allows a much smaller uncertainty in the contribution of the seed pressure to the temperature then integrating at the top of the profile, where the geophysical variability is sufficiently large which causes temperature retrievals to be unreliable for the first 10 or more km.

The PCL climatology has been obtained by the nightly average temperature profiles for 575 nights on which measurements of sufficient quality based on signal-to-noise ratio exist from the beginning of 1994 to 2013. The raw photon-count profiles recorded by the PCL Rayleigh lidar (24 m altitude resolution and 1 min time resolution) were co-added over the entire observation period in time and to an altitude resolution of 1008 m to calculate the temperature profile for each individual night by 2 methods. The nightly averaged temperature profiles were used to form a composite year of measurements which linear interpolation and 33 day triangular filter was used to fill in temperatures on nights where no measurements exist.

Then the climatology temperature obtained by each method was compared together. Result of inversion method in comparison with conventional method gives the almost same result to 95 km moreover reasonable results for extra heights to about 103 km with comparable standard deviation and more accuracy.

Importance Of Physico-Chemical Properties Of Aerosols In The Formation Of Arctic Ice Clouds

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Ice clouds play an important role in the Arctic weather and climate system but interactions between aerosols, clouds and radiation are poorly understood. Consequently, it is essential to fully understand their properties and especially their formation process.

Extensive measurements from ground-based sites and satellite remote sensing reveal the existence of two Types of Ice Clouds (TICs) in the Arctic during the polar night and early spring. TIC-1 are composed by non-precipitating very small (radar-unseen) ice crystals whereas TIC-2 are detected by both sensors and are characterized by a low concentration of large precipitating ice crystals. It is hypothesized that TIC-2 formation is linked to the acidification of aerosols, which inhibit the ice nucleating properties of ice nuclei (IN). As a result, the IN concentration is reduced in these regions, resulting to a smaller concentration of larger ice crystals. Over the past 10 years, several parameterizations of homogeneous and heterogeneous ice nucleation have been developed to reflect the various physical and chemical properties of aerosols (Hoose et Möhler, 2010). These parameterizations are derived from laboratory studies on aerosols of different chemical compositions. The parameterizations are also developed according to two main approaches: stochastic (that nucleation is a probabilistic process, which is time dependent) and singular (that nucleation occurs at fixed conditions of temperature and humidity and time-independent).

This research aims to better understand the formation process of TICs using a newly-developed ice nucleation parameterizations. For this purpose, we implement some parameterizations (2 approaches) into the Limited Area version of the Global Multiscale Environmental Model (GEM-LAM) and use them to simulate ice clouds observed during the Indirect and Semi-Direct Arctic Cloud (ISDAC) in Alaska. We use both approaches but special attention is focused on the new parameterizations of the singular approach. Simulation results of the TICs-2 observed on April 15th and 25th (polluted or acidic cases) and TICs-1 observed on April 5th (non-polluted cases) will be presented.

Influence of large-scale climate variability on the inter-annual variation of surface ozone depletion events in the Arctic spring

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In the Arctic spring, near-surface ozone can decrease to extremely low levels due to chemical loss catalyzed by halogen (mainly bromine) radicals. These ozone depletion events (ODEs) are usually accompanied by greatly enhanced surface deposition of reactive gaseous mercury having a harmful contribution to the Arctic ecosystem. The monthly (here in April) ODE frequency shows very large inter-annual variation. To analyze whether some of these variations are due to regional climate variability, we use surface ozone measurements at three monitoring sites in the Arctic such as Barrow, Alert, and Zeppelinfjellet (ZPL) during the past 30 years. In years with high ODE frequencies at Barrow and Alert in April, the Western Pacific (WP) teleconnection pattern is usually reveals negative phase, which is the period showing strengthened subtropical jet across the Pacific but the weakened storm track from western Pacific into the Arctic. Both factors seem to reduce transport of ozone-rich air masses from mid-latitudes to the Arctic, creating a favorable environment for ODEs in the Arctic. ODE frequencies at ZPL with those at Barrow and Alert show a shift of correlations from negative R value in the 1990s to positive in the 2000s. Now that ODE frequencies at ZPL also shows the similar decadal change of correlations with WP pattern, the decadal shift from the 1990s to 2000s looks to reflect a much stronger influence of the WP pattern on ODEs at ZPL in the more recent decade. In other words, it could potentially be used as a proxy to diagnose ODE changes and subsequent environmental impacts in the Arctic spring in future climate projections.

Wind, Temperature and Gravity Wave Observations with ERWIN-II

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The E-Region Wind Interferometer (ERWIN-II) is a Michelson interferometer which measures winds in the mesosphere by detecting Doppler shifts in the airglow layers; specifically greenline (557.7 nm), OH (843 nm) and O_2 (860 nm). ERWIN-II has been taking wind measurements at the PEARL observatory in Eureka, Nu since 2008. Through use of a quad mirror in the optical train, ERWIN-II is able to make simultaneous high precision (~1 m/s for green line and OH, and ~4 m/s for O_2) wind measurements in the four cardinal directions (north, east, south, and west) and zenith, at a very high observational cadence (~3 minute cycle through all three emissions). This combination of high precision and observational cadence allows the observation of vertical winds, high frequency phenomena (e.g. gravity waves), as well as tides and planetary waves. Additionally, atmospheric temperatures can be determined from the observed airglow line visibilities. Observations of gravity waves in both the wind and irradiance measurements, the correlations between these measurements, and preliminary atmospheric temperature measurements will be presented.

The Impact of Changing Cloud Cover on the High Arctic's Primary Cooling to-space Windows

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In the Arctic, most of the infrared energy emitted by the surface escapes to space in two atmospheric windows at 10 and 20 μm. As the Arctic warms, the 20 μm cooling-to-space window becomes increasingly opaque (or "closed"), trapping more surface infrared radiation in the atmosphere, with implications for the Arctic's radiative energy balance. Since 2006, the Canadian Network for the Detection of Atmospheric Change (CANDAC) has measured downwelling infrared radiance with an Atmospheric Emitted Radiance Interferometer (AERI) at the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Canada, providing the first long-term measurements of the 10 and 20 μm windows in the high Arctic. In this work, measurements of the distribution of downwelling 10 and 20 μm brightness temperatures at Eureka are separated based on cloud cover, providing a comparison to an existing climatology from the Southern Great Plains (SGP). Measurements of the downwelling radiance at both 10 and 20 μm exhibit strong seasonal variability as a result of changes in temperature and water vapour, in addition to variability with cloud cover. When separated by season, brightness temperatures in the 20 μm window are found to be independent of cloud thickness in the summertime, indicating that this window is closed in the summer. Radiance trends in three-month averages are positive and are significantly larger (factor > 5) than the trends detected at the SGP, indicating that changes in the downwelling radiance are accelerated in the high Arctic compared to lower latitudes. This statistically significant increase (> 5% / yr) in radiance at 10 μm occurs only when the 20 μm window is mostly transparent, or "open" (i.e., in all seasons except summer), and may have long-term consequences, particularly as warmer temperatures and increased water vapour "close" the dirty window for a prolonged period. These surface-based measurements of radiative forcing can be used to quantify changes in the high-Arctic energy budget and evaluate general circulation model simulations.

Impact of volcanic ash on snow and permafrost hydrology, Iceland

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Extensive ash and aeolian dust on snow have significant impacts on the availability and quality of water resources in both volcanically active and other wind-blown regions. While little dust or ash on snow surfaces can accelerate snowmelt and quicken the runoff, few studies have systematically explored the hydrological impacts of too much ash on arctic snowpacks, in particular its role in insulating and delaying snowmelt, promoting growth of permafrost/frozen ground and altering surface and subsurface flow, especially in geothermally sensitive regions such as Iceland. Coupled to this hydrological uncertainty is the added complexity of climate variability/change. For Iceland, recent climate change models predict higher temperatures and heavier precipitation (rainfall and snowfall). Additional extreme events will trigger added occurrences of rapid flooding from ash/mud-choked streams further disrupting water supplies and affecting roads and bridges. Availability of suitable hydrological models and algorithms to explore and anticipate these events, both here and in other similar terrain are lacking.

This poster introduces objectives and methods of the proposed research. Field measurements and numerical modeling will provide new information on ash-snowmelt runoff processes in sporadic permafrost, volcanically active catchments, and with respect to climate change in Iceland. The goal of this study is to i) use field and experimental approaches to evaluate both slope and catchment runoff in response to varying volcanic ash cover across Iceland’s diverse terrain including areas devoid of permafrost and geothermal activity versus sites containing sporadic permafrost and warm groundwater owing to “hot spots”; ii) refine and customize a cold regions hydrology model with new algorithms for ash-snow-permafrost processes, including modifications for geothermally active terrain, ultimately improving understanding of these processes; iii) integrate field and modeling work with GIS and remote sensing to identify source areas of potential water and ash/mud floods in non-glacial basins across Iceland under present conditions and future extreme events (climatic and volcanic eruptions).

This research will provide new data and further the understanding of ash-snowmelt runoff in geothermal areas, both at the present time as well as simulating conditions in the future. An improved arctic hydrological model for volcanically active or dusty regions will provide water resource managers an analytical tool to address hazardous conditions, including water quality/quantity and delivery issues.

Parameterization of homogeneous ice nucleation within the GEM model

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Clouds occupy a key position for the modulation of the atmospheric radiation and for the hydrologic cycles. They become even more important in the Arctic since these interactions can be strengthened by the presence of aerosols (Grenier and Blanchet, 2010; Morrison et al., 2005). Recently, a study has shown that clouds made purely of ice are ubiquitous in the upper troposphere, at all time, in the Arctic (Shupe, 2011; Devasthale et al., 2011). The existence of these ice clouds could be important in the Arctic spring to maintain phase low clouds (Morrison et al., 2005, 2012) or in the winter when the warming effect of the cloud feedback effect is more important.

Simulations with GEM result in a highly overestimated concentration of ice crystals in the upper troposphere for temperatures below -40ºC. These results are likely due to the homogeneous freezing parameterization in the model not representing this physical process properly. This might be caused by the coating of chemical compounds on the ice nuclei.

In order to fix this problem, the current parameterization of the model must be modified to include the chemical composition of the non-activated haze droplets. A few solutions can be found within recently published articles.

One idea that was studied numerous times was the water activity theory (Koop et al., 2000). The problem with this theory is that a single freezing temperature, also known as $T_f(a_w)$, curve doesn’t represent experimental data for the homogeneous freezing of sulfuric acid and ammonium sulfate solutions which are two important solutions found in the atmosphere. To fix this problem, each solute would need to have a seperate curve to obtain their homogeneous freezing temperature (Swanson, 2008).

Another aspect to consider is the possibility of mixed-phase particles, composed of a pure ice core and a residual solution coating which will slow the rate of the ice growth by 10^3 compared to uncoated ice, due to the sulfuric acid and the ammonium sulfate. This coating effect can produce important differences within the model, especially for radiation since it will increase the water vapor lifetime in the upper troposphere and it may change the radiative properties of cold cirrus clouds (Bogdan and Molina, 2009).

In this poster, an overview of the current homogeneous freezing parameterization in GEM and possible modifications that can improve the modelling of this process will be presented.

Calibrating the Candac RMR Lidar for depolarization measurements

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The radiative behaviour of clouds is dependent on cloud particle phase. Water droplets can exist in temperatures well below 0° C for extended periods. Lidar depolarization ratio measurements allow liquid and solid states to be differentiated in individual clouds at high spatial-temporal resolution. The 2012, 2013 and 2014 Canadian Arctic ACE Validation Campaigns in Eureka, Nunavut, Canada (80°N, 86°W) provided an opportunity to make extensive depolarization measurements using the CANDAC Rayleigh-Mie-Raman Lidar (CRL) in the troposphere.

For depolarization measurements to be correctly interpreted, the measurements must be well-calibrated. To date, most calibration methods in the literature work well only for lidars which do not have non-ideal polarizing optics upstream of the polarizing analyzers in the receiver. These calibrations are not perfect for the CRL, in which the depolarization channel was added downstream of six other pre-existing lidar channels.

This poster demonstrates a more complete matrix algebra calibration of the CRL to take the extra upstream optics into account. Differences in interpretation of the clouds in the atmosphere above Eureka are demonstrated to show the advantage of the more extensive calibration for this lidar compared to the more simple traditional approach.

The largest differences between the simple and more complete approaches are found in the lower range of linear depolarization parameter values where most of the CRL measurements lie, particularly at values less than $d = 0.3$ (corresponding to depolarization ratio $\delta = 0.18$). As $\delta = 0.2$ to 0.3 are generally taken to be the cutoff between interpretations of ice (higher δ) or water (lower δ), it is doubly important to have correctly calibrated these values for interpretation of the atmosphere.

Examining the effects of changing catchment condition on the nutrient behaviour and aquatic ecology of Arctic lakes

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Although there is widespread recognition of the over-arching influences of climate on Arctic aquatic ecosystems, there has been less focus on understanding indirect catchment-mediated processes that could influence the influence of climate variability. The supply of nutrients from catchments is likely an important driver of aquatic production for northern lakes, however, the response of aquatic biota to changes in catchment processes and nutrient supply is not well understood, and is often seen as secondary to direct temperature effects. To address this knowledge gap, we utilize a biogeographic approach that targets lakes across multiple northern regions experiencing changes to their catchment condition (e.g., thermokarst expansion, enhanced vegetation, thaw polygon formation). Sediment cores collected from these lakes archive geochemical and biological indicators that are sensitive to changing climate and catchment conditions and their stratigraphic records provide important temporal perspective. We compare chironomid assemblages from the uppermost sediments of these lakes across northern North America to hydrological, limnological, and environmental parameters using direct gradient analysis. While differences in temperature explain the largest amount of variation in chironomid assemblages, significant nested secondary relationships with dissolved organic carbon and nitrogen are identified. Lakes with higher dissolved organic carbon and nutrients in cold environments could potentially have chironomid assemblages that are similar to less productive warmer environments due to differences in food supply. Likewise, specific relationships between taxa and multiple food-supply related factors were prominent in ecotone areas. Lakes in areas of ecological transition, where catchments may experience changes in the delivery of dissolved organic carbon and nutrients, were found to be particularly sensitive to secondary gradient effects. Thus, future non-linear responses to climate warming may occur in lakes susceptible to changes in their catchment condition, which could accelerate biogeochemical cycling and trophic shifts.

Fitting CO_2 Lab Spectra to Improve TCCON Airmass Dependence

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The Total Carbon Column Observing Network (TCCON) is a network of ground-based Fourier transform spectrometers (FTS) that record solar absorption spectra. From these spectra one can retrieve precise amounts of column-averaged dry air mole fraction (Xgas) of CO_2, CH_4, N_2O, CO, H_2O and HDO. The goal of TCCON is to provide a useful data set in order to validate space based measurements of greenhouse gases and help understand how greenhouses gases exchange between the atmosphere, biosphere and ocean. A 1 ppm accuracy is needed by satellite measurements of XCO_2, when trying to resolve regional fluxes (Miller et al., 2007). This requires ground-based measurements have an accuracy greater than 1 ppm in order to be useful for satellite validation.

Studies by Hartman et al. (2008) and Thompson et al. (2012) show that the Voigt profile is inadequate to model the spectral line shape of CO_2 and is one of the causes of an airmass dependence seen in XCO_2 at TCCON sites. The Voigt profile assumes that spectral lines are collisionaly isolated and when they are not, collisions will transfer intensity from one line to another (line mixing).

In this study I used a line shape profile that takes into account both line mixing and speed dependence (variable speed at time of collision) effects to calculate absorption coefficients in GFIT. I then fitted a CO_2 lab spectrum with both a Voigt and speed dependent Voigt with Line mixing (SDV+LM). The spectral fit was greatly improved when the absorption coefficients were calculated using the SDV+LM line shape.

Investigating links between shell growth in Northern Norway and North Atlantic climate dynamics

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Understanding of physical and chemical ocean/atmosphere dynamics in recent centuries is important for refining global climate models and forecasts. Annually resolved, long-term records from the extratropical oceans are limited, contributing to an incomplete understanding of Arctic and Antarctic marine climate change and interactions. The development of such records, especially from polar regions, is therefore critical to improving our understanding of large-scale climate dynamics. The long-lived marine bivalve proxy, *Arctica islandica*, can be used gain insight into the impacts of large-scale climate variability on benthic marine ecology in northern Norway and thus evaluate the potential to use shell growth and geochemical records derived from a master shell chronology as a proxy for North Atlantic climate variability. Approximately 300 shells were collected live in 2009 and 2013 from the islands of Ingøy and Rolvsøy, located at the boundary between the Barents and Norwegian Seas. A master shell growth chronology constructed from nine shells documents 100 years of synchronous shell growth at Ingøy. Combining shell growth information with oxygen isotope measurements collected from annual increments yields an annually-resolved, multi-proxy record of environmental conditions. A relatively strong inverse relationship is observed between the shell-based multiproxy record and North Atlantic sea surface temperatures (1972-2011). The spatial pattern of correlation resembles that of the North Atlantic Current, indicating that large-scale ocean surface current dynamics play a role in regulating ecosystem processes and thus shell growth in northern Norway. These results suggest that further development of the multi-proxy record will be useful for understanding North Atlantic variability for the past several centuries.

Production and Transport of Ozone from Boreal Forest Fires

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The Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites (BORTAS) mission was planned by several universities and government agencies in the United Kingdom, Canada, and USA, and was funded by the UK Natural Environmental Research Council, with meteorological field support from the UK Meteorological Office and Environment Canada. It was conducted in two phases: July and August 2010 (BORTAS-A) and 2011 (BORTAS-B). The main goal of the campaign was to better understand the chemical evolution of plumes emitted from wildfires in boreal regions, with a particular emphasis on the net production of tropospheric ozone and downwind impacts on air quality (Palmer et al., 2013). The first phase of the experiment (BORTAS-A) comprised of ground-based, ozonesonde, and satellite measurements over eastern Canada in the summer of 2010. Aircraft measurements were cancelled due to a volcanic eruption in Iceland. The second phase (BORTAS-B) was an aircraft measurement campaign based out of Halifax, Nova Scotia, Canada, between 12 July and 3 August 2011, also supported by ground-based, ozonesonde, and satellite measurements.

In this study, the nearly 100 ozone soundings that were made during the experiment each year, as well as several satellite data sets, were used to investigate the connection between tropospheric ozone production and forest fires. Large amounts of ozone precursors such as NO2 and CO are observed in OMI (Ozone Monitoring Instrument), MOPITT (Measurements Of Pollution In The Troposphere), AIRS (Atmospheric InfraRed Sounder) and TES (Tropospheric Emission Spectrometer) satellite data close to large fires in the middle to upper troposphere. The detection of NO2 indicates that not all NO2 is converted to PAN. These chemical conditions can produce ozone in sunny weather. Also, layers of elevated ozone are detectable in ozonesonde profiles downwind at several sites, following days with large fire activity. Back-trajectories indicate that the elevated ozone is traceable to the large fires. The average ozone content of the air parcels traceable to the fires is 10 to 30% larger than the average of parcels at the same height which are not traceable to the fires. Lidar profiles also detect layers of aerosol at the same heights. However, in some cases the layers of high ozone are also associated with low humidity, which is not expected from a combustion source, and suggests the possibility of entrainment of stratospheric air.

Implementation of Carbon Flux Due to Sea Ice Algae in a 1D Biogeochemical Ecosystem Model in the Arctic

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Air-sea gas exchange is an essential process in determining the amount of carbon in the atmosphere, and primary producers in the euphotic zone play an important role in the oceanic uptake of carbon. One area of particular interest is the Arctic ocean, where in addition to the pelagic ecosystem, first-year sea ice provides an environment for ice algae to contribute to this exchange. In the past it had been assumed that sea ice acts as a cap to air-sea gas exchange, but recent studies have shown that carbon in the ice is taken up or released into both the atmosphere and ocean through chemical and biological processes during ice formation and melting. These processes need to be included in a representative air-sea-ice model of carbon exchange in the Arctic. The purpose of this study is to incorporate sea ice algae into a working ecosystem model set to conditions in Arctic sea ice formation and melting regions. The 1D General Ocean Turbulence Model is used for physical forcing along with sea ice implementation. The ecosystem component is comprised of two phytoplankton groups, two zooplankton groups, bacteria, detritus, nitrate, ammonium, and silicate. Sea ice algae are limited by nutrients as well as light and ice melt rate, and in areas of melting ice in the Arctic, ice algae blooms are typically observed in late spring or early summer, when nutrients have not yet been depleted in the lower ice layer, and snow and ice melt to allow light through to the bottom of the ice. Model development, validation, and sensitivity analyses are ongoing in order to compare the timing and magnitude of the spring bloom for the simulated ice algae to those from observations at key sites including Resolute Bay. Ultimately, the aim is to incorporate parameterisations from this 1D model into a coupled ocean-atmosphere regional model for the Arctic.

Atmospheric Drivers of Spring Snowmelt Trends on the Headwaters of the Mackenzie River

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The largest hydrological event on the Mackenzie River is the spring freshet, initiated by snowmelt on alpine tributaries, driving river ice break-up, flooding high-latitude basins, and injecting a pulse of freshwater into the Arctic Ocean. Evidence indicates that the timing of the spring freshet is occurring significantly earlier, raising concerns over the role of changing spring freshet conditions on the Arctic Ocean freshwater budget. This research quantifies trends in spring (Mar-May) snowmelt from 1950-2010 in the Liard, Peace, and Athabasca Rivers using a temperature-index snowmelt model at 10 km grid resolution and identifies the synoptic-scale atmospheric circulation patterns driving these trends. This analysis is a focused component of a larger study evaluating winter snowpack; therefore, daily winter (Nov-Apr) geopotential heights at 500 hPa are classified using Self-Organizing Maps (SOM), which clusters and projects dominant synoptic patterns onto an organized array. Gridded temperature anomalies at 10 km resolution corresponding to each synoptic type are then identified to determine which types are associated with above/below average surface climate. The synoptic type frequencies during spring snowmelt onset (Mar-Apr) are isolated and evaluated using the non-parametric Mann-Kendall test for trend. May is characterized by widespread significant decreases in snowmelt, while Mar-Apr analyses reveal significant increases in snowmelt, indicative of a shift toward an earlier onset of snowmelt in these alpine headwaters. Results from spring synoptic climatological analysis reveal an increase of high-pressure ridging over the study region, which is associated with above average temperatures and consistent with enhanced Mar-Apr snowmelt in the Liard, Peace, and Athabasca watersheds. Knowledge of the atmospheric controls over surface hydroclimatic variables is fundamental to our understanding of changing seasonal flow patterns on the Mackenzie River.

Variability of Arctic Sea Ice Export and Deformation through Nares Strait

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Nares Strait is a major conduit for sea-ice export from the Arctic Ocean and thus affecting climate and human activities further south. Due to the large role that Nares Strait plays in the Arctic sea-ice regime, the conditions and dynamics of this region could further contribute to overall depletion of ice formation and thickness – the Arctic sea ice mass balance. The goal of this study is to i) process buoy data from Nares Strait and use the results to study ice drift variability, ii) to retrieve ice motion from RADARSAT imagery and to calculate ice flux through the strait to extend the time series of ice flux through Nares Strait from 1997-2013, and, iii) to validate satellite data used to measure ice drift. This project will look at data from 1997-2013. Buoy data will be obtained and analyzed from past years, as well as from newly deployed instruments, to examine the ice drift in Nares Strait; buoy data provides validation of satellite data as well as real-time ice motion and meteorological data. Observational data via buoys are available hourly and will provide sufficient coverage to compare to satellite data. Data acquired via buoys as well as the buoy data processed will also be shared with the International Arctic Buoy Program (IABP). Ice motion will be retrieved from RADARSAT imagery via the Canadian Ice Service-Automated Sea Ice Tracking System. Ice flux will be calculated calibrated to a gate through Robeson Cannel (North entrance to Nares Strait). Finally, NCEP/NARR data will be investigated and used to incorporate climate trends, primarily of winds and temperature observations, with meteorological data obtained from buoys to further understand the dynamic forcing on ice motion in the region and to answer how variability has changed over time.

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Long-term size-segregated Cloud Condensation Nuclei counter (CCNc) measurements in a boreal environment and the implications for cloud droplet activation

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Ambient aerosol CCN and hygroscopic properties were measured with a size-segregated CCNc in a boreal environment of Southern Finland at the SMEAR II station since February 2009. The overall median critical diameter D_c for CCN activation is reported at 75 nm, exhibiting a clear minimum in February and a maximum in July. The overall median aerosol hygroscopicity parameter κ is reported at 0.22, indicating that ambient aerosol in Hyytiälä is less hygroscopic than the global continental and European continental averages. It is, however, more hygroscopic than ambient aerosol in an Amazon rainforest, the European high alpine site or the mountainous forest. The low hygroscopicity in the boreal forest is attributed to a large organic fraction present in the aerosol mass comparative to other locations within Europe. Various long-term measurements of gas and particle phase atmospheric constituents were used to demonstrate a positive correlation between κ and sulphate and sulphuric acid, and a negative correlation between κ and the organic mass fraction, monoterpenes and isoprene. Atmospheric nitric acid and nitrate mass fraction were found to decrease κ; the correlations, however, were poor and inconclusive No distinguishable effect of atmospheric new particle formation (NPF) on D_c and κ was observed. Ambient aerosol was found to be internally mixed in the summer, and externally mixed during the rest of the year. The use of a single, mean or median, κ to describe the whole aerosol population is discouraged due to log-normal distributions of κ and their dependence on the size.

Ice clouds and the NETCARE field experiment

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Ice clouds play an important role in the Arctic weather and climate system. Consequently, it is essential to understand their properties and especially their formation process. Remote sensing observations over the Arctic have revealed the existence of two types of ice clouds (TIC). The first type, TIC-1, is characterized by a high concentration of small ice crystals and is typically observed in non-polluted areas. On the other hand, TIC-2 is characterized by a low concentration of larger precipitating ice crystals.

In this study, it is hypothesised that TIC-2 are linked to highly polluted environments. Past field experiments have shown that most aerosols in the accumulation mode are coated by sulphuric acid in polluted episodes in the Arctic during winter. Recent laboratory experiments have shown that sulphuric acid coating can alter the efficiency of ice nuclei (IN) to nucleate ice crystals. In this study, we hypothesize that the resulting lower IN concentration found in polluted air masses leads to the decrease of the ice crystal concentration. Since there is in less competition for the available moisture, ice crystals reach precipitating sizes leading to the formation of TIC-2.

This research aims to better understand the formation process of these two types of TIC during the NETCARE (Network on Climate and Aerosols Addressing Key Uncertainties in Remote Environments) Arctic campaign that will take place in April 2015. In-situ measurements of ice cloud microstructure (ice crystal size, chemical composition, IN, etc.) will be performed using the Polar5 aircraft as well as continuous ground-based IN measurement by filter conducted in Alert (82°30′05″N 62°20′20″W). It will be the first long term measurement of IN in Canada.

My M.Sc. research project will be related to the analysis of the data gathered during the Netcare campaign with a special focus on the ice nucleation process. In this poster we present the main goal of the study and a general overview of the ice cloud measurements that will be performed during NETCARE.

Identifying the Origins of Trace Metals in Particulate Matter in the Athabasca Oil Sands Region

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Particulate matter, composed of a mixture of organic and inorganic particles, has been linked to cardiovascular and respiratory health impacts. Trace metals can serve as useful markers for identifying the sources of airborne particulate matter. Through the Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring Program, hourly trace metals in particulate matter smaller than 2.5 µm were measured in the Athabasca region of Alberta. As part of this program, an intensive measurement campaign was executed at a Wood Buffalo Environmental Association research site (AMS 13) from August 10 to September 5, 2013.

A semi-continuous X-ray fluorescence instrument, the Xact625 (Cooper Environ.), was used to measure hourly concentrations of 15 metal species; Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, and Sr. Elements such as Se, V, and S were examined for their relationships with anthropogenic sources, while Si, Ca, and Fe, typically associated with crustal material, were examined due to the extensive mining and traffic in the area that contributes to the suspension of dust. The high time resolution of this device enabled the capture and identification of sources of trace metals involved in short-term episodes. Positive matrix factorization was used together with wind sector analysis to identify the relevant sources close to oil sands processing activities. The methodology used to identify the sources of metals, and its application to data from the oils sands region will be described. We anticipate applying similar metals-based positive matrix factorization to snow samples from the arctic that will be collected in winter, 2014.

Preliminary comparisons between the Environment Canada Carbon Assimilation System and data from the TCCON network for CO_2

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The Environment Canada Carbon Assimilation System (EC-CAS) is being developed in order to obtain routine estimates of global and regional fluxes of greenhouse gases. The ability to understand and predict the carbon cycle in the context of a changing climate is an important scientific goal with implications for global climate policy. The project started in April 2011 as a collaboration between Environment Canada, the University of Toronto, and the University of Waterloo. EC-CAS is based on the EnsKF (Ensemble Kalman Filter) and the GEM-MACH (Global Environment Multiscale – Modelling Air quality and CHemistry) model.

The Total Carbon Column Observation Network (TCCON) is a network of ground-based Fourier transform infrared spectrometers recording direct solar spectra in the near-infrared spectral region. It provides column-averaged dry mole fractions (DMFs) of CO_2, CO_2 N_2O, CH_4, H_2O, HDO, and HF at high precision.

The purpose of this study is to compare data from EC-CAS to TCCON measurements to determine how well the model can simulate methane and carbon dioxide. This model is still under development and the results shown are preliminary. The comparison procedure described in Wunch et al. (2010) will be presented. The data covers 13 sites for the year 2009 and is processed using a new Python code. Time series of EC-CAS and TCCON column averaged CO_2 DMFs will be shown, as well as a priori profiles for CO_2.

Wunch, D., et al. (2010): Calibration of the Total Carbon Column Observing Network using aircraft profile data, *Atmospheric Measurement Techniques,* **3 (5)**, 1351-1362.

Characterizing the Overlap Function of the CANDAC Rayleigh-Mie-Raman Lidar (CRL) in Eureka, Nunavut

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The CANDAC Rayleigh-Mie-Raman Lidar (CRL) is stationed in the Canadian Arctic in Eureka, Nunavut (80N, 86W). It measures various physical properties of the atmosphere such as temperature, water vapor concentrations, depolarization ratios, and particle backscatter cross section coefficients from the ground up to the mid-stratosphere. At low altitudes the CRL measurements have a reduction in photon counts due to an incomplete transmitter-receiver overlap and therefore an altitude dependent correction, known as the overlap function, is used. The observed overlap is modeled using a simple thin-lens model with four main adjustable parameters; the FOV of the telescope, the positioning of the field stop at a displacement δ from the focal length of the telescope, the beam divergence, and the zenith angle of the laser beam. Good agreement between the observed and modeled overlap functions allow the instrument's characteristics to be better understood and improve its performance at low altitudes.

Initialization and potential predictability of snow in the Canadian Seasonal to Interannual Prediction System (CanSIPS)

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Snow is the component of the cryosphere having the largest seasonal variation. Seasonal snow cover plays a central role in the Earth's hydrology and the surface energy balance, and has a major effect on climate and biogeochemical cycling. A fundamental quantity describing seasonal snow cover is snow water equivalent (SWE), which is defined as the depth of water that would result from the melting of a column of snow. SWE is useful for climate prediction as it contains regional information about previous climate anomalies and influences future climate on seasonal timescales. We study the initialization and predictability of snow in hindcasts from the Canadian Seasonal to Interannual Prediction System (CanSIPS). CanSIPS is a two-model forecasting system that combines ensemble forecasts from the Canadian Centre for Climate Modeling and Analysis coupled climate models CanCM3 and CanCM4, which share common ocean, land surface and sea ice components but differ in their atmospheric component. CanSIPS initializes land surface variables such as SWE from the response of the land component to meteorological conditions in the data-constrained atmospheric model that takes place while the coupled model is running. The initialization of each ensemble member (10 for each model) is performed by a separate assimilation run, which gives rise to ensemble spread in the SWE initial conditions. Forecasts are performed by running each ensemble member freely from the initial conditions provided by the assimilation runs. We first assess the ability of the initialization procedure employed by CanSIPS to represent SWE realistically, using gridded observational data products for comparison. We examine the accuracy of these initialized values in terms of the seasonal cycle and interannual variability. We then study the predictability of SWE in the forecast runs. Predictability is understood in terms of 'potential predictability' (PP), which depends on the ratio of ensemble spread to the climatological or equilibrium spread and is highest when this ratio is small. The temporal and geographical dependence of PP in the CanSIPS forecasts is described.

The influence of canopy snow parameterizations on snow albedo feedback in boreal forest regions

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Variation in snow albedo feedback (SAF) among CMIP5 climate models has been shown to explain much of the variation in projected 21st Century warming over Northern Hemisphere land. Prior studies using observations and models have demonstrated both considerable spread in the albedo, and a negative bias in the simulated strength of SAF, over snow-covered boreal forests. Boreal evergreen needleleaf forests are capable of intercepting snowfall throughout the winter, which has a significant impact on seasonal albedo. Two satellite data products and tower-based observations of albedo are compared with simulations from multiple versions of the Community Climate System Model (CCSM4) to investigate the causes of weak simulated SAF over the boreal forest. The largest bias occurs in April-May, when simulated SAF is one-half the strength of SAF in observations. This is traced to two features of the canopy snow parameterizations used in the land model. First, there is no mechanism for the dynamic removal of snow from the canopy when temperatures are below freezing, which results in albedo values in midwinter that are biased high. Second, when temperatures do rise above freezing, all snow on the canopy is melted instantaneously, which results in an unrealistically early transition from a snow-covered to a snow-free canopy. These processes combine to produce large differences between simulated and observed monthly albedo, and are the source of the weak bias in SAF. This analysis highlights the importance of canopy snow parameterizations for simulating the hemispheric scale climate response to surface albedo perturbations.

Sea ice decline and changing primary productivity in the Bering Sea during Marine Isotope Stage 11

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Arctic sea ice is a key component of the global climate system. However, the extent of Arctic summer sea ice has been at or near a record low six times within the past decade and the extent of multi-year ice is declining at an even faster rate as surface temperatures continue to rise at almost twice the global average. Climate models based on past sea ice trends predict an almost ice-free Arctic summer by 2030. This change in baseline conditions holds implications for albedo and the radiative budget, global ocean circulation, global carbon cycling, primary productivity and the atmospheric circulation patterns that link Arctic sea ice extent to mid-latitude weather conditions. In order to better understand the likelihood, and impacts, of future sea ice decline, the natural variability of sea ice has been advanced as a priority research question.

Given that satellite data only extends back to 1978, and that prior observations of sea ice are sparse at best, proxy records are needed to examine how sea ice responds to a changing climate, and to better understand the associated ecological changes that take place as sea ice advances or retreats. This work will focus on examining variations in sea ice and productivity during a previous warming at approximately 400 ka; the transition from Marine Isotope Stage (MIS) 12 to MIS 11, also known as Termination V. MIS 11 is the most recent interglacial during which orbital conditions were similar to today. Extreme warmth throughout this time is recognized in the proxy record and considered as an analog for future warmth. MIS 11 is unique in the polar regions, and particularly so in Beringia, where glaciers advanced whilst sea level was still high. The Bering Sea, with its distinctive topography, and strategic location as a gateway between the Pacific and Arctic Oceans, at the dynamic margin of Arctic sea ice, is one of the most productive regions in the world's oceans and an ideal recorder of past sea ice variability. Across the Bering Sea, the history of sea ice extends back to the Pliocene and low resolution shipboard data indicate that sea ice varies significantly in sediments younger than 2.5 Ma.

Several proxies for sea ice extent will be applied to sediment cores from the Bering Sea, retrieved as part of Expedition 323 of the Integrated Ocean Drilling Program (IODP). Sites for this project were selected for their wide coverage of the Bering Sea, from the shelf-slope break (site U1343) to Bowers Ridge (U1340) and the Umnak Plateau (U1339). A diatom-based, quantitative sea ice proxy will provide the basis to evaluate changes in both past sea ice extent and productivity. This, combined with a multi-proxy approach to include grain size analysis, shipboard data (magnetic susceptibility; natural gamma ray; reflectance), diatom-bound nitrogen and basic geochemistry (%$CaCO_3$; % organic carbon; % bulk nitrogen), will allow for a robust, high resolution analysis of the spatial and temporal variability of sea ice and primary productivity during MIS 11, and thus provide a baseline against which current and future change can be measured.

Testing the new SFIT4 retrieval algorithm on the Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) dataset

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The Extended-range Atmospheric Emitted Radiance interferometer (E-AERI) is a ground-based Fourier transform spectrometer that measures the atmospheric downwelling infrared spectral radiance from 400 to 3000 cm^{-1} with a resolution of 1 cm^{-1} and a high sensitivity to the lower troposphere. The extended spectral range of the instrument provides coverage of the water vapour rotational band, measuring the atmospheric radiance in the 400-550 cm^{-1} (20-25 μm) region, where much of the infrared surface cooling occurs in the dry air of the Arctic.
The instrument was installed in October 2008 at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut. The E-AERI is taking measurements every seven minutes year-round (precipitation permitting) including during the polar night and provides information about radiative balance, trace gases, and cloud properties in the Canadian high Arctic.

In order to retrieve concentrations of trace gases, spectra collected by the E-AERI must be analyzed using a retrieval algorithm. SFIT2 is a radiative transfer and retrieval algorithm based on the Optimal Estimation Method and is used to derive atmospheric partial/total columns and profiles of atmospheric trace gases from solar absorption spectra. The SFIT2 retrieval code has been widely used in the infrared remote sounding community since 1998. An emission add-on has been developed for use with infrared emission spectra, such as those recorded by the E-AERI. This has been incorporated into the new version of the retrieval code, SFIT4, which was officially released in 2014.

This presentation will show preliminary retrievals of total columns of CO, O_3, N_2O and CH_4 from E-AERI dataset performed using SFIT4 (v0973), along with comparisons to previous SFIT2 results. Differences encountered will be investigated.

Gravity Wave Climatology over Eureka, Nunavut in 2008-2009

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The PEARL (Polar Environmental Artic Research Laboratory) All Sky Imager (PASI) has been in operation since 2007 at PEARL in Eureka, Nunavut. PASI is a CCD imaging system with six different spectral band narrow band filters. The filters installed in PASI are targeted at the following emissions: atomic sodium (at 589.3 nm), background (at 572.5nm), molecular nitrogen ion (at 427.8nm), atomic oxygen green line (at 557.7nm), atomic oxygen red line (at 630.0nm) and hydroxyl (at 720-910nm notched at 865nm due to the molecular oxygen). PASI takes an image on average every minute while cycling through the different filters with the hydroxyl filter interleaved between the other filters in the sequence.

This poster will present the automated analysis approach developed to detect gravity waves present in the images taken by PASI. The gravity wave parameters of interest are the background wind corrected speed, intrinsic period, and propagation direction. In each image occurrences of these waves are defined in terms of horizontal spatial wavenumber and phase. Temporal phase information is deduced from consecutive images which contain wave signatures with similar wavenumbers. Vertical wavelength is determined from consecutive images between the different filters using an approach similar to determining the temporal phase. Monthly variations of these quantities along with uncertainty and their correlation with each other during the 2008-2009 winter season will be presented.

Characterizing water vapor measurements of the Purple Crow Lidar

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In 2012, the Purple Crow Lidar (PCL) participated in a water vapor validation campaign with the NASA/GSFC ALVICE lidar. Results showed that the PCL water vapor measurements were consistently higher than ALVICE, prompting an investigation into the system's performance. Simulated lidar returns have been produced by a function generator and is processed using an optimal estimation algorithm. This robust inversion method provides a mean to solve nonlinear equations, allowing it to determine detector deadtime and better characterize the photomultiplier tubes' capacity.

A New Pointing System for the SPS Instrument for Balloon and Space Applications

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In order to validate the corrected ozone data from ground-based Brewer instruments and satellite based instruments measuring ozone, a series of balloon-based experiments will be conducted. The SPS (SunPhotoSpectrometer) instrument designed and built by Dr. C.T. McElroy will be flown on board this experiment. These balloon experiments are part of the PARABLE training program which stands for Payload for Remote sounding of the Atmosphere using Balloon Limb Experiments. PARABLE will act as a platform to conduct measurements of trace gases and aerosols using solar occultation and limb measurements. This project uses a high altitude balloon platform flying at 35 to 40 km altitude provided by CNES (Centre national d'études spatiales), the French Space Agency.

In order to achieve fine sun tracking for spectrometer based instruments onboard balloon experiments or satellite missions a new pointing system is being designed and built. There are several types of these pointing mirror platforms available but they are expensive and complicated. A new simple and inexpensive design has been suggested in this paper to be tested on a series of balloon missions. This design is to be perfected to apply to space applications in the future.

Cloud identification in the Canadian High Arctic using the UV-visible colour index

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In UV-visible spectroscopy, Rayleigh and Mie scattering contribute to the broadband extinction seen in spectra of scattered sunlight. The relative intensity of these two components of scattering is highly dependent on the cloud condition of the sky. The colour index, defined as the ratio of light intensities at different wavelengths, typically 350 nm and 550 nm, provides a means of determining the cloud conditions.

A UV-visible triple-grating spectrometer, the UT-GBS (University of Toronto Ground-Based Spectrometer), was installed at the Polar Environment Atmospheric Research Laboratory (PEARL), at Eureka in the Canadian High Arctic (86.4°W, 80.1°N) in 1999. Since then, the instrument has made daily measurements during spring from 1999-2009, and year-round, with the exception of polar night, from 2010-2013. The UT-GBS measures vertical column densities of ozone, NO_2, and BrO, as well as slant column densities of enhanced OClO, by using the Differential Optical Absorption Spectroscopy (DOAS) technique. We use the colour index data from the UT-GBS to distinguish polar stratospheric clouds and tropospheric clouds.

The UV-visible measurements are supplemented by vertically resolved lidar and radar cloud data products. The CANDAC (Canadian Network for the Detection of Atmospheric Change) Rayleigh-Mie-Raman Lidar (CRL) and the Millimetre Cloud Radar (MMCR) are located at the Zero Altitude PEARL Auxiliary Laboratory (0PAL), which is about 15 km away from PEARL. The CRL uses ultra-short pulses of light from two lasers, operating at ultraviolet (355 nm) and visible (532 nm) wavelengths. The CRL measures the vertical distribution of aerosols, temperature, and water vapour in the troposphere and lower stratosphere. The zenith-pointing MMCR measures equivalent radar reflectivity, Doppler velocity, spectral width, and Doppler spectra, from which information about cloud heights, thicknesses, internal structure and vertical motions can be determined.

Polar stratospheric cloud (PSC) events have been observed during spring by the UT-GBS and the CRL; these will be discussed in the context of the location of the polar vortex relative to Eureka, stratospheric temperatures, and stratospheric ozone loss events. In addition to detecting PSCs, the colour index can be used for the detection of tropospheric clouds. The UT-GBS cloud index results are in good agreement with data from the MMCR. Thus the cloud index can be useful for assessing the quality of DOAS retrievals, which can be greatly affected by tropospheric clouds.

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End of Program